NASA CR- 175260

THE DEVELOPMENT OF A HIGH-CAPACITY INSTRUMENT MODULE HEAT TRANSPORT SYSTEM

Appendixes

final report to

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

prepared by

ARTHUR D. LITTLE, INC.
CAMBRIDGE, MASSACHUSETTS 02140

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APPENDIX A

INSTRUMENT THERMAL DATA BASE

1. INSTRUMENT THERMAL DATA SHEETS

for

SOLAR PHYSICS

INSTRUMENT GROUPING

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Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

White Light Coronograph

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Solar Corona Temperature Measurements

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 180 kg*

Size (sketch?): 75 x 75 x 200 cm

Aperture(s)/Radiator(s): Aperture Solar Viewing End *

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: 7200 km

apogee:

Pointing Direction: Sun (Sun Synchronous)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 23/17°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

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POWER DISSIPATIONS

Operating (max/min): 100W

Non-operating (max/min):

* ADL interpretations

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Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Lyman Alpha Coronograph

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Solar Corona Temperature Measurements

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 100 kg*

Size (sketch?): 50 x 50 x 300 cm

Aperture(s)/Radiator(s): Aperture Solar Viewing End*

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: 7200 km

apogee:

Pointing Direction: Sun (Sun. Synchronous)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 23/17°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

POWER DISSIPATIONS

Operating (max/min): 100W

Non-operating (max/min):

* ADL interpretations

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Solar Magnetic and Velocity Field Measurements (telescope)

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Study solar magnetic & velocity fields

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 75 kg

Size (sketch?): .75 x .75 x 2 cm

Aperture(s)/Radiator(s):

Gimbaled (?): Yes

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: High

Altitude/perigee: 400 km

apogee:

Pointing Direction: Sun (Sun synchronous)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 11/9°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

POWER DISSIPATIONS

Operating (max/min): 200W

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME
Solar Irradiance Spectrometer

STATUS
SL-1 reflight

PRINCIPAL CONTACT(S)
Center National D'etudes Spatiales, France

SCIENTIFIC OBJECTIVE
Measure the solar spectral irradiance from 180 to 3200 nm and their long term variabilities

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 23 kg

Size (sketch?): 61 x 44 x 32 cm

Aperture(s)/Radiator(s): 32 x 44 cm aperture*

Gimbaled (?): Yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: >150 km

apogee:

Pointing Direction: Sun

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 40/10°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 100

Non-operating (max/min):

* ADL interpretation

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME
Solar Constant Variability

STATUS
SL-1 reflight

PRINCIPAL CONTACT(S)
Institut Royal Meteorologique de Belgique

SCIENTIFIC OBJECTIVE
Measure the absolute value of the solar constant and its long term variations

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 6 kg

Size (sketch?): 43 x 16 x 16 cm (sketch available)

Aperture(s)/Radiator(s): 16 x 16 cm aperture*

Gimbaled (?): Yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: >150 kw

apogee:

Pointing Direction: Sun

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 40/-20°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 5W

Non-operating (max/min):

* ADL interpretation

Instrument Thermal Data Sheet

Code: SUSIM	Mod: 1	Date: 1/81

INSTRUMENT NAME

Solar UV Spectral Irradiance Monitor

STATUS

Reflight of OSS-1 hardware*

PRINCIPAL CONTACT(S)

NRL
(Rein Ise/MSFC)

SCIENTIFIC OBJECTIVE

Improve the existing accuracy of solar flux measurements in the 120-400 nm region and to establish variations of this flux over a solar cycle.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 55 kg (106 kg)

Size (sketch?): 86 x 29 x 77 cm (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): Yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 0-90°

Altitude/perigee: >300 km

apogee:

Pointing Direction: Sun

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25/15°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 45W (320W)

Non-operating (max/min):

* ADL interpretations - () indicate other data reference

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Active Cavity Solar Irradiance Monitor

STATUS

Reflight of SL-1 hardware

PRINCIPAL CONTACT(S)

R. Wilson (JPL)

SCIENTIFIC OBJECTIVE

Determine the total solar irradiance at 1AU with 0.1% accuracy in solar irradiance units.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 25 kg

Size (sketch?): 30 x 30 x 20 cm (sketch available)

Aperture(s)/Radiator(s): (yes/4 holes)

Gimbaled (?): Yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: 1200 km

apogee:

Pointing Direction: Sun

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 50/10°C (cold plate)

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 10 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME
Solar Gamma Ray Experiment

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE
Study of gamma rays from solar flares

HARDWARE DESCRIPTION

Flight Vehicle:
Mass: <2000 kg
Size (sketch?): 1m dia x 3m
Aperture(s)/Radiator(s):
Gimbaled (?):
Critical Thermal Component(s):

ORBIT/ORIENTATION
Inclination: 28

Altitude/perigee: 400 km
apogee:
Pointing Direction: Sun
Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument
Operating (max/min):
Control Band:
Non-operating (max/min):

— Critical Component(s)
Component/location:
Operating (max/min):
Control Band:
Non-operating (max/min):

— Cryogenics
(Load/Temperature): 50w/100K (not total instrument)

POWER DISSIPATIONS
Operating (max/min): 500W
Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME
Solar Physics Soft X-Ray Facility

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)

SCIENTIFIC OBJECTIVE
Study of sun's inner corona and transition zone

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?): 1 m x 1 m x 7m

Aperture(s)/Radiator(s): 1m

Gimbaled (?): Yes

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Full sun desirable

Altitude/perigee: $\geq$ 400 km

apogee:

Pointing Direction: Sun (sun synchronous)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 350W

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod:	Date:

INSTRUMENT NAME
100 meter Pinhole Camera

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE
Solar Physics/High Energy Astrophysics
Hard X-Ray Imaging (2-20 kw)

HARDWARE DESCRIPTION

Flight Vehicle:
Mass: 1000 kg
Size (sketch?): 1m x 1m x 2m (100 m boom)
Aperture(s)/Radiator(s):
Gimbaled (?):
Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Low
Altitude/perigee: 400 km
apogee:
Pointing Direction: Solar and Celestial
Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument
Operating (max/min):
Control Band:
Non-operating (max/min):

— Critical Component(s)
Component/location:
Operating (max/min):
Control Band:
Non-operating (max/min):

— Cryogenics
(Load/Temperature):

POWER DISSIPATIONS
Operating (max/min): 500 w
Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

1 km Pinhole Camera

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Solar Physics/High Energy Astrophysics

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 3000 kg (mask)
2700 kg (detector package)

Size (sketch?): 2 cm x 20 m dia (mask) 1 m x 1 m (detector package) see sketch

Aperture(s)/Radiator(s): 40-60 cm aperture

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Low

Altitude/perigee: $\leq$ 400 km

apogee:

Pointing Direction: Sun and inertial (sun synchronous)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 500 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: SOT	Mod: 1	Date: 1/81

INSTRUMENT NAME
Solar Optical Telescope

STATUS
Planned Start

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Diffraction limited resolution of .1 arc sec on the sun

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 6600 kg

Size (sketch?): 7.3 m x 3.8 m dia

Aperture(s)/Radiator(s): 1.25 m

Gimbaled (?): Yes

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: High (57°)

Altitude/perigee: $\geq$ 450 km (463 km)

apogee:

Pointing Direction: Sun (sun synchronous desired)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 2000W

Non-operating (max/min):

2. INSTRUMENT THERMAL DATA SHEETS

for

SPACE PLASMA PHYSICS

INSTRUMENT GROUPING

Instrument Thermal Data Sheet

Code: AGWA	Mod: 1	Date: 1/81

INSTRUMENT NAME

Atmospheric Gravity Wave Antenna

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Properties of gravity waves and their role in energy transfer to and within the mesosphere and thermosphere.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass:

Size (sketch?): 100 m dia antenna

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 56°

Altitude/perigee: $\geq$ 250 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

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POWER DISSIPATIONS

Operating (max/min):

Non-operating (max/min):

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Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Magnetic Pulsations

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Induce (artificial magnetic pulsations in themagnelosphere
(ground-based detection)

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?): 1 km antenna

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 56°

Altitude/perigee: Geosynchronous

apogee:

Pointing Direction:

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 25 kw

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: PBI	Mod: 1	Date: 1/81

INSTRUMENT NAME

Particle Beam Injection Experiment

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Active perturbation of ionosphere

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 300 kg (diagnostic pkg)

Size (sketch?): 1 x 1 x 1.5 m (diagnostic package) 100 x 100 m (acceleration screens)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: $\geq 56°$

Altitude/perigee: 400 km

apogee:

Pointing Direction: Earth Magnetic lines

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 100 w (diagnostic pkg)

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: PDP	Mod: 1	Date: 1/81

INSTRUMENT NAME

Plasma Diagnostic Package

STATUS

Instrument being developed as Free-Flyer

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

Measure local plasma parameters, particle spectra, wave spectra

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 2000 kg

Size (sketch?): Pallet sized

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 50°

Altitude/perigee: 300 - 30,000 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 250 w

Non-operating (max/min):

3. INSTRUMENT THERMAL DATA SHEETS

for

ASTRONOMY

INSTRUMENT GROUPING

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

UV Spectropolarimeter

STATUS

Proven similar design exists (concept)

PRINCIPAL CONTACT(S)

A. Code (University of Wisconsin)

SCIENTIFIC OBJECTIVE

Obtain UV spectropolarimetry of galactic and extra-galactic sources

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 200 kg

Size (sketch?): 70 cm dia x 150 cm (cassagian telescope)

Aperture(s)/Radiator(s): 50 cm aperture

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: Any

apogee:

Pointing Direction:

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25 ± 5°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

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POWER DISSIPATIONS

Operating (max/min): 70 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Broad-band X-ray telescope

STATUS

proven similar design exists (concept)

PRINCIPAL CONTACT(S)

P. Serlemitsos (GSFC)

SCIENTIFIC OBJECTIVE

Measure non-induced and other spectral features in X-ray sources with a broad-band, high resolution instrument.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 260 kg (+35 kg cryogen)

Size (sketch?): 450 x 100 x 50 cm (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): Yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination:

Altitude/perigee: > 300 km

apogee:

Pointing Direction: stellar

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25 $\pm$ 5°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): yes

POWER DISSIPATIONS

Operating (max/min): 260 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

UV Imaging Telescope

STATUS

Adapt from existing hardware

PRINCIPAL CONTACT(S)

T. Stecher (GSFC)

SCIENTIFIC OBJECTIVE

Perform astronomical investigations in the UV range

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 170 kg

Size (sketch?): 44 cm dia x 267 cm

Aperture(s)/Radiator(s): 38 cm aperture

Gimbaled (?): Yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 0 - 50°

Altitude/perigee: 20 - 600 km

apogee:

Pointing Direction: Stellar

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20 ± 10°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 50

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Far UV Telescope/Spectrometer

STATUS

Adapt from existing hardware

PRINCIPAL CONTACT(S)

A. Davidson (Johns Hopkins University)

SCIENTIFIC OBJECTIVE

Study a broad sample of quasars and active galactic nuclei with emphasis on wavelengths below 1200 A°.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 400 kg

Size (sketch?): 117 cm dia x 300 cm (add 100 cm for sunshade)

Aperture(s)/Radiator(s): 117 cm aperture*

Gimbaled (?): Yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: < 250 km

apogee:

Pointing Direction: Stellar

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): $-10 \pm 10°C$

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 200

Non-operating (max/min):

* ADL interpretation

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Small Cryogenically Cooled Telescope

STATUS

In development (SL-2)

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S. H. Morgan (HQ)
G. Fazio (SAO)

SCIENTIFIC OBJECTIVE

Wide field of view for IR survey of selected areas

HARDWARE DESCRIPTION

Flight Vehicle:

Size (sketch?): 3.4 x 1.78 x 1 m (sketch available)

Aperture(s)/Radiator(s): 6 inch aperture

Gimbaled (?):

Critical Thermal Component(s):

Mass: 725 kg (includes 250 liters of helium)

ORBIT/ORIENTATION

Inclination: < 45°

Altitude/perigee: 250 km - 500 km

apogee:

Pointing Direction: Stellar/inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 30 - 100°C

Non-operating (max/min): -30 to 100°C

Control Band:

— Critical Component(s)

Component/location:

Operating (max/min):

Non-operating (max/min):

Control Band:

— Cryogenics

(Load/Temperature): superfluid helium

POWER DISSIPATIONS

Operating (max/min): 130 w ± 10

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: SWAT	Mod: 1	Date: 1/81

INSTRUMENT NAME

Spacelab Wide Angle Telescope

STATUS

Feasibility study completed 6/79

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S. H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Full-sky UV survey, identification and classification of cosmological structures.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 900 kg

Size (sketch?): 2.75 x 1.15 x 4,3 m (sketch available -OSS)

Aperture(s)/Radiator(s): 1 m aperture

Gimbaled (?): Yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar/inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25°C/film

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 600 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

3-5 m antenna for VLBI

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Submillimeter IR astronomy

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: $\leq$ 3500 kg

Size (sketch?): 3-5 m antenna & 1 pallet süpport equipment

Aperture(s)/Radiator(s): 3-5 m dia (antenna

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 57°

Altitude/perigee: $\leq$ 300 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): cryogens needed at detector

POWER DISSIPATIONS

Operating (max/min): < 1000 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

UV Photometric Polarimeter

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Time dependent event study of quasars, Seyfert galaxies & certain X-ray sources.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 70 kg

Size (sketch?): .5 x 2 x 1 m

Aperture(s)/Radiator(s): 40-50 cm

Gimbaled (?): Yes

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min):

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

EUV Spectrograph

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

High spectral resolution study of interstellar medium

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 500 kg

Size (sketch?): .5 x 5 x 1 m

Aperture(s)/Radiator(s):

Gimbaled (?): Yes

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min):

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

1.5 m UV Optical Light Collector

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Astronomical measurements (UV photometry, spectroscopy, polarimetry)

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 3000 kg

Size (sketch?): 1 pallet sized (includes focal plane instruments)

Aperture(s)/Radiator(s): 1.5 m aperture

Gimbaled (?): most likely*

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Celestial, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20 ± 10°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): ≤ 1500 w

Non-operating (max/min):

* ADL interpretation

Instrument Thermal Data Sheet

Code: SIRTF	Mod: 1	Date: 1/81

INSTRUMENT NAME

Space IR Telescope Facility

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Conduct definitive high sensitivity IR photometric and spectroscopic studies

HARDWARE DESCRIPTION

Flight Vehicle:

Size (sketch?): 14 x 3 x 3m (sketch available

Aperture(s)/Radiator(s): 1 m aperture

Gimbaled (?): Yes

Critical Thermal Component(s):

Mass: 250 kg (+ 2500 kg cryogenic system)

ORBIT/ORIENTATION

Altitude/perigee: > 350 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions: (telescope mirror cannot view earth albedo)

Inclination: 28°

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Non-operating (max/min):

Control Band:

— Critical Component(s)

Component/location:

Operating (max/min):

Non-operating (max/min):

Control Band:

— Cryogenics

(Load/Temperature): 1 w/10 k

POWER DISSIPATIONS

Operating (max/min): 2 kW

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: STARLAB	Mod: 1	Date: 1/81

INSTRUMENT NAME

Meter class UV and planetary telescope

STATUS

Planned, concept evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Optical astronomical observations in the UV and visual

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 2000 kg

Size (sketch?): 1.5 m dia x 5 m (sketch available)

Aperture(s)/Radiator(s): 1 m aperture

Gimbaled (?): Yes (telescope)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 350 - 800 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): none

POWER DISSIPATIONS

Operating (max/min): 1000 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: AST/TEL	Mod: 1	Date: 1/81

INSTRUMENT NAME

Astrometric Telescope for Planet Detection

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Use for search of extra-solar planetary systems

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 4500 kg

Size (sketch?):

Aperture(s)/Radiator(s): 1.5 m aperture

Gimbaled (?): Yes (IPS mounted telescope)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20 $\pm$ 5°C

Control Band:

Non-operating (max/min): 20 $\pm$ 5°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): −100° C(CCD arrays)

POWER DISSIPATIONS

Operating (max/min): 1000 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: IR-TEL	Mod: 1	Date: 1/81

INSTRUMENT NAME

Large Ambient Deployable IR Telescope

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

IR astronomy 10 - 1000 microns

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 16,000 kg

Size (sketch?): 15 m dia x 35 m (artists sketch available)

Aperture(s)/Radiator(s): >12 m aperture (possible 20 m)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 - 700 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): TBD

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location: Primary mirror must be at ambient

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): LHe (detectors)

POWER DISSIPATIONS

Operating (max/min): 1000 w (TBD)

Non-operating (max/min):

4. INSTRUMENT THERMAL DATA SHEETS

for

HIGH ENERGY ASTROPHYSICS

INSTRUMENT GROUPING

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Low-energy Gamma Ray Spectrometer

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Detect and measure nuclear liner from discrete objects and diffuse regions of the galaxy

HARDWARE DESCRIPTION

Flight Vehicle:

Size (sketch?): 10 m x 5 m dia

Aperture(s)/Radiator(s): 3 m dia aperture

Gimbaled (?):

Critical Thermal Component(s):

Mass: 10,000 kg (not including expendable cryogens)

ORBIT/ORIENTATION

Inclination: $\leq$ 28°

Altitude/perigee: < 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20 $\pm$ 10°C

Control Band:

Non-operating (max/min): 20 $\pm$ 10°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): 20 w/100 k (cryogenics or active refrigeration)

POWER DISSIPATIONS

Operating (max/min): 150 w

Non-operating (max/min):

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Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME
Large Area Timing Facility Proportional Counter and Scintillator

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Perform detailed time variable studies with high resolution of compact X-ray sources.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 250 kg

Size (sketch?): 1.3 x 1.3 x 1.5 m

Aperture(s)/Radiator(s): 1.3 x 1.3 m aperture

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: $\leq 28°$

Altitude/perigee: 300-500 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): $20 \pm 10°C$

Control Band:

Non-operating (max/min): $20 \pm 10°C$

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

POWER DISSIPATIONS

Operating (max/min): 100 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME
Soft X-ray Survey Instrument

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE
Extend the HEAO-A soft X-ray survey and increase knowledge of the luminosity functions of these classes of X-ray sources

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?): 1 x 1 x 3 m

Aperture(s)/Radiator(s): 1 x 3 m aperture

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: $\leq 28°$

Altitude/perigee: 300 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): $20 \pm 10°C$

Control Band:

Non-operating (max/min): $20 \pm 10°C$

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

POWER DISSIPATIONS

Operating (max/min): 300 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME
High Energy Gamma Ray Telescope

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE
Study Spectra characteristics and spatial extent of HE gamma ray radiation (multi wire spart chamber, drift chamber, or proportional counter)

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 10,000 kg (pressurized)

Size (sketch?): 3 m dia x 4 m

Aperture(s)/Radiator(s):

Gimbaled (?): No*

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: ≤ 28°

Altitude/perigee: ≤ 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 0-30°C

Control Band:

Non-operating (max/min): 0-30°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

POWER DISSIPATIONS

Operating (max/min): 100 w

Non-operating (max/min):

* ADL interpretation

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Gamma Ray Burst Detector/Monitor (2 req'd)

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Establish location, spectrum, and time profile of bursts

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?): 4 m dia x 2 m

Aperture(s)/Radiator(s): 3 m dia hemisphere aperture

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial, anti-Earth (all sky)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 5-35°C

Control Band:

Non-operating (max/min): 5-35°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

POWER DISSIPATIONS

Operating (max/min): 120 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME
X-ray Polarimeter

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE
Study of compact galactic and extra-galactic sources

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?): 1 x 1 x 3 m

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 22 ± 5°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 150 w*

Non-operating (max/min):

* ADL interpretations

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

X-ray High Resolution Spectroscopy

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Study of compact galactic and extra-galactic sources

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?): 1.6 x 1.6 x 3 m

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 22 ± 5°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 150 w*

Non-operating (max/min):

* ADL interpretations

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Cosmic Ray Instrument - Isotopic Composition

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Improved understanding of elemental composition of cosmic rays - isotopic composition of Iron nuclei

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 3000 kg

Size (sketch?): 3 x 3 x 4 m

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 70°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions: Away from earth

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 0–30°C

Control Band:

Non-operating (max/min): 0–30°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): large volume of helium possible (super conducting magnet)

POWER DISSIPATIONS

Operating (max/min): 200 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

Cosmic Ray Radiation Transition Detector

STATUS

In Development (SL-2)

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S. H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Precise determination of charge composition and individual energy spectra of cosmic ray nuclei from Lithium to Iron.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1800 kg

Size (sketch?): 3.7 x 2.7 m (cylinder with hemispherical leads) (sketch available/pressurized)

Aperture(s)/Radiator(s): 2.7 m dia aperture

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination:

Altitude/perigee:

apogee:

Pointing Direction: Anti Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): −10 to 40°C

Control Band:

Non-operating (max/min): −40 to 60°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

POWER DISSIPATIONS

Operating (max/min): 230 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: LAMAR/PI	Mod: 1	Date: 1/81

INSTRUMENT NAME

Large Area Modular Array of Reflectors
(PI version)

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)
G. FAZIO (SAO)?

SCIENTIFIC OBJECTIVE

Optical and radial identification of extra-galactic sources

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?): 1.8 x 1 x 2.8 m

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 22 ± 5°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 150 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: LAMAR	Mod: 1	Date: 1/81

INSTRUMENT NAME

Large Area Modular Array of Reflectors

STATUS

Concept Evolving
(see earlier version)

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Determining the distribution of extra-galactic X-ray sources

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 2600 kg

Size (sketch?): 3 x 3 x 3 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: $\leq 28°$

Altitude/perigee: $\leq$ 400 km

apogee:

Pointing Direction: Stellar, inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): $22 \pm 5°C$

Control Band:

Non-operating (max/min): $22 \pm 5°C$

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 550 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME

All-sky X-Ray Monitor

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), S.H. Morgan (HQ)

SCIENTIFIC OBJECTIVE

Monitor long term intensity changes of sources on time scales of minutes to years

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 200 kg

Size (sketch?): 1.2 m^3 (6 units)

Aperture(s)/Radiator(s):

Gimbaled (?): No*

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: $\leq 28°$

Altitude/perigee: 400 km

apogee:

Pointing Direction: Stellar, inertial (all sky)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): $15 \pm 10°C$

Control Band:

Non-operating (max/min): $15 \pm 10°C$

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): None

POWER DISSIPATIONS

Operating (max/min): 120 w

Non-operating (max/min):

* ADL interpretation

5. INSTRUMENT THERMAL DATA SHEETS

for

RESOURCES OBSERVATIONS

INSTRUMENT GROUPING

Instrument Thermal Data Sheet

Code: OCE	Mod: 1	Date: 1/81

INSTRUMENT NAME

Ocean Color Experiment

STATUS

In development

PRINCIPAL CONTACT(S)

Thomas Buckler (GSFC)

SCIENTIFIC OBJECTIVE

Evaluation of passive ocean color manner technique for wrapping chlorophyll

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 124 kg

Size (sketch?): .94 x .76 x .43 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 38°

Altitude/perigee: 280 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 15 $\pm$ 35°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 180 w

Non-operating (max/min):

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Instrument Thermal Data Sheet

Code: PASS MICRO	Mod: 1	Date: 1/81

INSTRUMENT NAME

Passive Microwave Imager

STATUS

Planned Start

PRINCIPAL CONTACT(S)

Larry King (GSFC)

SCIENTIFIC OBJECTIVE

To perform passive microwave measurements of the earth for applications in the fields of meteorology, geophysics, hydrology, polar studies, and ship routing.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 325 kg

Size (sketch?): 3.8 x 3.6 x 4.3 m (sketch available)

Aperture(s)/Radiator(s): 4 m aperture

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 90°

Altitude/perigee: 900 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 470 w

Non-operating (max/min):

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Instrument Thermal Data Sheet

Code: GG	Mod: 1	Date: 1/81

INSTRUMENT NAME

Gravity Gradiometer

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

M. Page (MSFC)

SCIENTIFIC OBJECTIVE

Obtain an improved global model of the earth's gravitational field.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 6.8 - 9.1 kg

Size (sketch?):

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 90°

Altitude/perigee: 200-250 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): (needs cooling system)?

POWER DISSIPATIONS

Operating (max/min): ∿1w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: TM	Mod: 1	Date: 1/81

INSTRUMENT NAME

Thematic Mapper

STATUS

In development

PRINCIPAL CONTACT(S)

Oscar Weinstein (GSFC)

SCIENTIFIC OBJECTIVE

To gather earth resources data in a synoptic and repetitive manner.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass:

Size (sketch?): 2 x .7 x .9 m (sketch available)

Aperture(s)/Radiator(s): 4 m aperture)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 98°

Altitude/perigee: 705 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 27 ± 10°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): 100 K (passive cooler)*

POWER DISSIPATIONS

Operating (max/min): 280 w

Non-operating (max/min):

* ADL interpretation

Instrument Thermal Data Sheet

Code: LFC	Mod: 1	Date: 1/81

INSTRUMENT NAME

Large Format Camera

STATUS

In Development

PRINCIPAL CONTACT(S)

B. H. Mollberg (JSC)

SCIENTIFIC OBJECTIVE

Photography of the earth's land and ocean surfaces for geological exploration, cartography and renewable resources analysis (visible and near-IR)

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 537 kg

Size (sketch?): 1.2 x 1.5 x 2.2 m (sketch available)

Aperture(s)/Radiator(s): .05 m aperture

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 57°

Altitude/perigee: 273 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 21.5 ± 1°C

Control Band:

Non-operating (max/min): 21.5 ± 1°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 273 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: SMR-FP	Mod: 1	Date: 1/81

INSTRUMENT NAME
Soil Moisture Radiometer

STATUS
Planned

PRINCIPAL CONTACT(S)
Larry King (GSFC)

SCIENTIFIC OBJECTIVE
Determine feasibility of making large area moisture measurements from space using parabolic antenna

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 252 kg

Size (sketch?): 1.22 x 3.51 x 2.13 (sketch available)

Aperture(s)/Radiator(s): 15-20 m aperture (antenna)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 45-99°

Altitude/perigee: 400-600 km

apogee:

Pointing Direction: Earth (sun synchronous)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20 ± 10°C

Control Band:

Non-operating (max/min): 30 ± 20°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 500 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: SMR-PA	Mod: 1	Date: 1/81

INSTRUMENT NAME

Soil Moisture Radiometer

STATUS

Planned

PRINCIPAL CONTACT(S)

Larry King (GSFC)

SCIENTIFIC OBJECTIVE

Obtain global soil moisture measurements for crop yield forecasting, watershed management, and climate studies using phased array radar.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 475 kg

Size (sketch?): 10 x 3.3 x .6 m (sketch available)

Aperture(s)/Radiator(s): 10 x 10 m aperture

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 45-99°

Altitude/perigee: 400-600 km

apogee:

Pointing Direction: Earth (sun synchronous)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20 ± 10°C

Control Band:

Non-operating (max/min): 30 ± 20°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 51 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: SGRS	Mod: 1	Date: 1/81

INSTRUMENT NAME

Spacelab Geodynamic Ranking System

STATUS

Planned

PRINCIPAL CONTACT(S)

D. Premo (GSFC)

SCIENTIFIC OBJECTIVE

Develop and test laser ranging instrument which can be used to measure cm level motions on earth's surface to help forecast earthquakes.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 227 kg

Size (sketch?): 1.6 x .64 x 1.08 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 50°

Altitude/perigee: 400 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 17 to 32°C

Control Band:

Non-operating (max/min): -3°C to 52°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 800 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: TTE	Mod: 1	Date: 1/81

INSTRUMENT NAME

Time Transfer Experiment

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

Dr. Rudy Decker (MSFC)

SCIENTIFIC OBJECTIVE

To perform high accuracy time and frequency synchronization of atomic clocks on a world-wide basis.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 91 kg

Size (sketch?): .91 x 1.22 x 1.22 m

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 50–60°

Altitude/perigee: 800

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 150–200 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: LFS	Mod: 1	Date: 1/81

INSTRUMENT NAME

Laser Fluorescence Spectrometer

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

F. Hoge (WFC)

SCIENTIFIC OBJECTIVE

To induce fluorescence in natural terrestrial geological materials.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?):

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: near polar

Altitude/perigee: Low

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 3000 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: ERSAR	Mod: 1	Date: 1/81

INSTRUMENT NAME

Earth Resources Synthetic Aperture Radar

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

Charles Elochi (JPL)

SCIENTIFIC OBJECTIVE

To develop applications of space borne synthetic aperture radar for renewable and non-renewable resource exploration

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 808 kg

Size (sketch?): 2.7 x 1 x 1 m; 2.8 x 3.7 x 1.4 m (sketch available)

Aperture(s)/Radiator(s): 8 x 2.8 m (phased array)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 57°

Altitude/perigee: 225 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 3000 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: SIS	Mod: 1	Date: 1/81

INSTRUMENT NAME

Stereoscopic Imaging System

STATUS

Planned

PRINCIPAL CONTACT(S)

Al Conrad (JPL)

SCIENTIFIC OBJECTIVE

To obtain stereoscopic imaging of world's land masses in a single landsat type, far red or near IR spectral band.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 94 kg

Size (sketch?): 1.15 x 1.15 x 1.0 m (sketch available)

Aperture(s)/Radiator(s): (Yes)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 98°

Altitude/perigee: 713 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 75 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: MRS	Mod: 1	Date: 1/81

INSTRUMENT NAME

Multispectral Resource Sampler

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

William Meyer (GSFC)

SCIENTIFIC OBJECTIVE

To study of agricultural, forestry, geology, atmosphere disaster assessment and environmental quality

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 55 kg

Size (sketch?): .74 x 1.65 x .64 m (sketch available)

Aperture(s)/Radiator(s): (Yes)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 98°

Altitude/perigee: 705 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20 $\pm$ 5°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 85 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: FILE	Mod: 1	Date: 1/81

INSTRUMENT NAME

Feature Identification and Location Experiment

STATUS

Development

PRINCIPAL CONTACT(S)

Gordon Bullock (LaRC)

SCIENTIFIC OBJECTIVE

To improve data management in earth-observation missions and to reduce mission support costs.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 38 kg

Size (sketch?): .9 x .51 x 1.3 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: 160 - 480 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 35 ± 35°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 24 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: THM	Mod: 1	Date: 1/81

INSTRUMENT NAME

Tether Facility (Magnetometer)

STATUS

In development

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC), G. Newton (HQ)
J. Lave (MSFC)

SCIENTIFIC OBJECTIVE

Measurements of atmospheric and space plasma, and perturbations

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1000 kg

Size (sketch?): 3 m x 2 m x 4 m Launch boom extends to 50 m Tether reel out to 100 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28°, 70° (any)

Altitude/perigee: 200 km

apogee:

Pointing Direction: Earth and Anti-Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 21 ± 33.5

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 121 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: FLD	Mod: 1	Date: 1/81

INSTRUMENT NAME

Fraumhofer Line Discriminator

STATUS

In development

PRINCIPAL CONTACT(S)

William Hemphill (USGS)

SCIENTIFIC OBJECTIVE

Detect and measure geological features, pollutants, oil seeps and spills, and stressed vegetation by measuring sunlight induced fluorescence.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 60 kg

Size (sketch?): 1 m^3 (optical head), 1 x .5 x .5 m (electronics)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28 - 90°

Altitude/perigee: 200 - 800 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 20–30°C

Control Band:

Non-operating (max/min): 20–30°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 150 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: MMIRI	Mod: 1	Date: 1/81

INSTRUMENT NAME

Multispectral Mid-IR Imager

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

Alexander Goetz (JPL)

SCIENTIFIC OBJECTIVE

Geological observation of the earth by means of thermal IR images in 6 spectral bands between 8 - 12 μ.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 900 kg

Size (sketch?): 1.5 x 1 m dia

Aperture(s)/Radiator(s): ∿ 1 m

Gimbaled (?): yes/telesccpe

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Near polar

Altitude/perigee: < 800 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): yes (radiative or solid cryogen for detectors)

POWER DISSIPATIONS

Operating (max/min): 300 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: MTIRI	Mod: 1	Date: 1/81

INSTRUMENT NAME

Multiband Thermal IR Imager

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

John Barker (GSFC)

SCIENTIFIC OBJECTIVE

Thermal IR imaging of earth for geological and agricultural investigations.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass:

Size (sketch?):

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 57°

Altitude/perigee:

apogee:

Pointing Direction:

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min):

Non-operating (max/min):

6. INSTRUMENT THERMAL DATA SHEETS

for

ENVIRONMENTAL OBSERVATIONS

INSTRUMENT GROUPING

Instrument Thermal Data Sheet

Code: ATMOS	Mod: 1	Date: 1/81

INSTRUMENT NAME
Atmospheric Trace Molecule Spectrometer

STATUS
In development

PRINCIPAL CONTACT(S)
Larry Simmons (JPL)

SCIENTIFIC OBJECTIVE
Monitor environmental quality

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 250 kg

Size (sketch?): 1.07 x .9 x 1.09 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: Any

apogee:

Pointing Direction:

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25 $\pm$ 10°C (cold plate)

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

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POWER DISSIPATIONS

Operating (max/min): 225 w

Non-operating (max/min):

PAGE A-74 INTENTIONALLY BLANK

Instrument Thermal Data Sheet

Code: MAPS	Mod: 1	Date: 1/81

INSTRUMENT NAME

Measurement of Air Pollution from Shuttle

STATUS

In development

PRINCIPAL CONTACT(S)

R. T. Sherrill (LaRC)

SCIENTIFIC OBJECTIVE

Measure CO concentration in the wind and upper troposphere

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 80 kg

Size (sketch?): .76 x .9 x .58 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: Any

apogee

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25 ± 10°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 95 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: AEPI	Mod: 1	Date: 1/81

INSTRUMENT NAME

Atmospheric Emission Photometric Imaging

STATUS

In development

PRINCIPAL CONTACT(S)

Rein Ise (MSFC), W. C. Snoddy (MSFC), G. Newton (HQ)

SCIENTIFIC OBJECTIVE

To produce images of various atmospheric emissions

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 147 kg

Size (sketch?): 1.4 x .47 x 1.4 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): Yes (part of instrument)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 58°

Altitude/perigee: 250 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 0 - 40°C (pallet)
0 - 70°C (module)

Control Band:

Non-operating (max/min): -55 to 40°C (pallet) 0 to 70°C (module)

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 330 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: ISO	Mod: 1	Date: 1/81

INSTRUMENT NAME

Imaging Spectrometric Observatory

STATUS

Development

PRINCIPAL CONTACT(S)

Rein Ise (MSFC)

SCIENTIFIC OBJECTIVE

To measure daytime atmospheric spectrum over the wavelength range 300 - 12000°.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 245 kg

Size (sketch?): 1.1 x .86 x 1.31 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: 250 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): -30 to 35°C (pallet) 0 to 38°C (rack)

Control Band:

Non-operating (max/min): -40 to 60°C (pallet) -20 to 60°C (rack)

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 173 w (1000 w)*

Non-operating (max/min):

* ( ) indicate other sources of information

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Instrument Thermal Data Sheet

Code: HRDI	Mod: 1	Date: 1/81

INSTRUMENT NAME

High Resolution Doppler Imager

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

Milton Sing (GSFC)

SCIENTIFIC OBJECTIVE

Measure vector velocity field of winds from troposphere through thermosphere

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 191 kg

Size (sketch?): 1.25 x .6 x .8 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28–90°

Altitude/perigee: 250–500 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

~~Non-operating (max/min):~~

Operating	Non-operating
-20 to 90°C (MAST electronic)	-55 to 90°C
-100 to 100°C (MAST)	-100 to 100°C
-20 to 90 (Electronics)	-50 to 90
-5 to 30 (telescope)	-200 to 50

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 165 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: OSAR	Mod: 1	Date: 1/81

INSTRUMENT NAME

Ocean Synthetic Aperture Radar

STATUS

Development, Concept Evolving

PRINCIPAL CONTACT(S)

F. Barath (JPL)

SCIENTIFIC OBJECTIVE

Monitor sea roughness, wave patterns, ship movements, currents, ice extent, ice motion, ice age, and open areas.

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 250 kg

Size (sketch?): 20 x 2 x .2 m (antenna)
1 x 1 x .3 m (electronics)

Aperture(s)/Radiator(s): 20 x 2 m (phased array)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 90°, 80°

Altitude/perigee: 700 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 0 - 50°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): ∿300 w

Non-operating (max/min):

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Instrument Thermal Data Sheet

Code: ERBE	Mod: 1	Date: 1/81

INSTRUMENT NAME

Earth Radiation Budget Experiment

STATUS

Development

PRINCIPAL CONTACT(S)

D. Diller (HQ)

SCIENTIFIC OBJECTIVE

Gather earth radiation budget data to help understand climate and develop prediction techniques

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 55 kg

Size (sketch?): .36 x .33 x .30 m

Aperture(s)/Radiator(s): .42 x .42 x .46 m

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 98°, 64°

Altitude/perigee: 833 km, 600 km

apogee:

Pointing Direction: Earth (sun synchronous)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 50w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: CLIR	Mod: 1	Date: 1/81

INSTRUMENT NAME
Cryogenic Limb Scanning Interferometer Radiometer

STATUS
Planned

PRINCIPAL CONTACT(S)
Robert Drummond (GSFC)

SCIENTIFIC OBJECTIVE

Provide high resolution IR spectroscopic and radiometric measurements of emission from trace constituents in the stratosphere, mesophere, and lower thermosphere

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: >780 kg

Size (sketch?): 4.8 x 1.4 m dia (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): yes (IPS)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: <70

Altitude/perigee: 300 - 600 km

apogee:

Pointing Direction: Earth Limb

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): (Solid hydrogen)

POWER DISSIPATIONS

Operating (max/min): 125 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: MLS	Mod:	Date:

INSTRUMENT NAME

Microwave Limb Sounder

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

J. W. Waters (JPL)

SCIENTIFIC OBJECTIVE

To measure millimeter thermal emission from certain important gases in earth's upper atmosphere

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 100 kg

Size (sketch?): 2.3 x 1.9 x .8 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): Yes (IPS?)

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 90°

Altitude/perigee: 250 km

apogee:

Pointing Direction: Earth's Limb

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): (passive & cold plate)

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 400 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: LIDAR	Mod: 1	Date: 1/81

INSTRUMENT NAME

Light Detection and Ranging Facility

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

E. Browell (LaRC)

SCIENTIFIC OBJECTIVE

To study transport, dissipation, excitation, and photochemistry of the upper atmosphere

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1430 kg

Size (sketch?): full pallet (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 57°

Altitude/perigee: 185 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 2634 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: LAMMR	Mod: 1	Date: 1/81

INSTRUMENT NAME

Large Antenna Multi-Frequency Microwave Radiometer

STATUS

Planned Start

PRINCIPAL CONTACT(S)

Larry King (GSFC)

SCIENTIFIC OBJECTIVE

Passive microwave measurements of the earth, ocean and atmosphere for applications in the fields of meterology, geophysics, hydrology, polar studies, and ship routing

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 325 kg

Size (sketch?): 3.8 x 3.6 x 4,3 (sketch available)

Aperture(s)/Radiator(s): 4m aperture (antenna)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 90°

Altitude/perigee: 900 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 470 w (200/electronics)

Non-operating (max/min): (135/each radar)

Instrument Thermal Data Sheet

Code: DFS	Mod: 1	Date: 1

INSTRUMENT NAME

Dual Frequency Scatterometer

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)
J. Johnson (LaRC)

SCIENTIFIC OBJECTIVE

Microwave scatterometry of oceans

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 150 kg

Size (sketch?): 4.6 x .15 x .3 m (each antenna-3) (sketch available)

Aperture(s)/Radiator(s): 4.6 x .3 m/phased array antenna (3)

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 90°

Altitude/perigee: 400-1000 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 0 - 35°C

Control Band:

Non-operating (max/min): 0 - 35°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 200w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: ICE	Mod: 1	Date: 1/81

INSTRUMENT NAME
Ice and Climate Experiment

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
Sam Willis (GSFC)

SCIENTIFIC OBJECTIVE

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 3526 kg

Size (sketch?): (sketch available) 4m antenna
3m rod antennas (5)
Aperture(s)/Radiator(s): 20cm beryllium mirror

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 87°

Altitude/perigee: 275 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 2260 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: DAA	Mod: 1	Date: 1/81

INSTRUMENT NAME
Dual Antenna Altimeter

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)

J. McGoogan (WFC)

SCIENTIFIC OBJECTIVE

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: >200 kg

Size (sketch?):

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 65°

Altitude/perigee: 1000 km

apogee:

Pointing Direction: Earth (oceans)

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 0-35°C

Control Band:

Non-operating (max/min): -20 to 55°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 425 w

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: UARS	Mod: 1	Date: 1/81

INSTRUMENT NAME
Upper Atmospheric Research Satellite
(comprised of several individual instruments already defined)

STATUS
Planned

PRINCIPAL CONTACT(S)
Richard Austin (GSFC)

SCIENTIFIC OBJECTIVE

Study energetics, chemistry, dynamics, transport and coupling among different processes of the stratosphere and mesosphere (15-85 km)

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 4077 kg

Size (sketch?): 5.3 x 4.5 m dia.

Aperture(s)/Radiator(s):

Gimbaled (?):

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 56°, 70°

Altitude/perigee: 250-600 km

apogee:

Pointing Direction: Earth

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min):

Non-operating (max/min):

7. INSTRUMENT THERMAL DATA SHEETS

for

MATERIALS PROCESSING

INSTRUMENT GROUPING

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Instrument Thermal Data Sheet

Code: MEA	Mod: 1	Date: 1/81

INSTRUMENT NAME

Materials Experiment Assembly

STATUS

PRINCIPAL CONTACT(S)

SCIENTIFIC OBJECTIVE

Materials processing in low-g environment

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 1190 kg

Size (sketch?): 1.1 x 1.1 x 1.7 m

Aperture(s)/Radiator(s): None

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: Any

apogee:

Pointing Direction: None

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 4–49°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 8500 w

Non-operating (max/min):

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Instrument Thermal Data Sheet

Code: SES	Mod: 1	Date: 1/81

INSTRUMENT NAME

Solidification Experiment System

STATUS

PRINCIPAL CONTACT(S)

SCIENTIFIC OBJECTIVE

Materials processing in low-g environment

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 900 kg

Size (sketch?): 1 m x 1.5 m x 3 m* (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: Any

apogee:

Pointing Direction: None

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 10-40°C

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 3000 w

Non-operating (max/min):

* ADL estimate

Instrument Thermal Data Sheet

Code: MEC	Mod: 1	Date: 1/81

INSTRUMENT NAME

Materials Experiment Carrier

STATUS

PRINCIPAL CONTACT(S)

SCIENTIFIC OBJECTIVE

Materials processing in low-g environment

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 5100 - 14100 kg

Size (sketch?): 4.6 x 4.6 x 3.1 m (sketch available

Aperture(s)/Radiator(s): None

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: Any

Altitude/perigee: Any

apogee:

Pointing Direction: None

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min):

Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 10–25 kw

Non-operating (max/min):

Instrument Thermal Data Sheet

Code:	Mod: 1	Date: 1/81

INSTRUMENT NAME **STATUS**

Crystal Growth Experiment

PRINCIPAL CONTACT(S)

SCIENTIFIC OBJECTIVE

Materials processing in low-g environment

HARDWARE DESCRIPTION

Flight Vehicle: Mass: 1500 kg

Size (sketch?): ∿ .5 m dia x 1 m* (10 cylinders/sketch available)

Aperture(s)/Radiator(s): None

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION Inclination: Any

Altitude/perigee: Any

apogee:

Pointing Direction: None

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): Control Band:

Non-operating (max/min):

— Critical Component(s)

Component/location:

Operating (max/min): Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 2500 w

Non-operating (max/min):

* ADL interpretation

8. INSTRUMENT THERMAL DATA SHEETS

for

LIFE SCIENCES

INSTRUMENT GROUPING

Instrument Thermal Data Sheet

Code: LS/LAB	Mod: 1	Date: 1/81

INSTRUMENT NAME

Life Sciences Laboratory Module

STATUS

Concept Evolving

PRINCIPAL CONTACT(S)

W. C. Snoddy (MSFC)

SCIENTIFIC OBJECTIVE

Provide laboratory research capability in medicine, psychology, man-machine, biology, and life-support systems

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 6800 kg

Size (sketch?): 4 m dia x 7 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28.5°

Altitude/perigee: 350 km

apogee:

Pointing Direction: Inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25 ± 3°C

Control Band:

Non-operating (max/min): 25 ± 3°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature): Yes (TBD)

POWER DISSIPATIONS

Operating (max/min): 8 kw (workday)

Non-operating (max/min):

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Instrument Thermal Data Sheet

Code: LOG/MOD	Mod: 1	Date: 1/81

INSTRUMENT NAME
Logistics Module

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC)

SCIENTIFIC OBJECTIVE
Provide increased platform capability for research and habitability

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 7260 kg

Size (sketch?): 4 m dia x 4 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28.5°

Altitude/perigee: 350 km

apogee:

Pointing Direction: Inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25 ± 3°C

Control Band:

Non-operating (max/min): 25 ± 3°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 2 kw

Non-operating (max/min):

Instrument Thermal Data Sheet

Code: LHAB	Mod: 1	Date: 1/81

INSTRUMENT NAME
Long Habitability Module

STATUS
Concept Evolving

PRINCIPAL CONTACT(S)
W. C. Snoddy (MSFC)

SCIENTIFIC OBJECTIVE
Provide normal habitability for crew of 4 up to 90 days

HARDWARE DESCRIPTION

Flight Vehicle:

Mass: 10,000 kg

Size (sketch?): 4 m dia x 7 m (sketch available)

Aperture(s)/Radiator(s):

Gimbaled (?): No

Critical Thermal Component(s):

ORBIT/ORIENTATION

Inclination: 28.5°

Altitude/perigee: 350 km

apogee:

Pointing Direction: Inertial

Pointing Restrictions:

TEMPERATURE REQUIREMENTS

— Instrument

Operating (max/min): 25 ± 3°C

Control Band:

Non-operating (max/min): 25 ± 3°C

— Critical Component(s)

Component/location:

Operating (max/min):

Control Band:

Non-operating (max/min):

— Cryogenics

(Load/Temperature):

POWER DISSIPATIONS

Operating (max/min): 5 kw (1987) 10 kw (1989)

Non-operating (max/min):

APPENDIX B

SYSTEM SPECIFICATION FOR A HIGH-CAPACITY INSTRUMENT MODULE HEAT-TRANSPORT SYSTEM

PREPARED BY		NUMBER ADLHTS-001
David W. Almgren		TYPE FINAL
APPROVALS	Arthur D. Little, Inc. SPECIFICATIONS	DATE January 15, 1981
		SUPERSEDES SPEC. DATED: November 26, 1980
		REV. LTR. A — PAGE 1 of 24 pages

TITLE

A HIGH CAPACITY INSTRUMENT MODULE HEAT TRANSPORT SYSTEM

1.0 PURPOSE:

The purpose of this specification is to define the design requirements or, for some parameters, the design goals, of a high-capacity, two-phase heat transport system (a thermal utility) to be used with future orbiting payloads. This specification forms the common basis for the preliminary design, comparative assessment and initial development of heat transport systems based on alternative technologies, e.g., pumped two-phase and heat pipes. This specification does not exclude consideration of a hybrid system which combines the best features of a pumped two-phase and a heat pipe system.

2.0 BACKGROUND:

2.1 General

The thermal control of multidisciplinary instruments on future space platforms and pallets may require a heat rejection system that can transport multi-kilowatt loads over distances on the order of tens of meters. Figure 1 is a drawing of one configuration of NASA's proposed Science and Applications Space Platform (SASP) showing a possible arrangement of the multidisciplinary instrument. Each instrument typically has a set of specified temperature limits for operating and non-operating conditions. An energy balance on each instrument includes internal power dissipation as well as a net radiative and conductive heat exchange with its environment.

The satisfaction of the energy balance of an instrument so as to maintain its temperature level within specified limits can be accomplished either by 1) thermally designing the instrument to have its own, independent thermal subsystem, or 2) thermally designing the instrument to be partly or totally dependent on a common heat

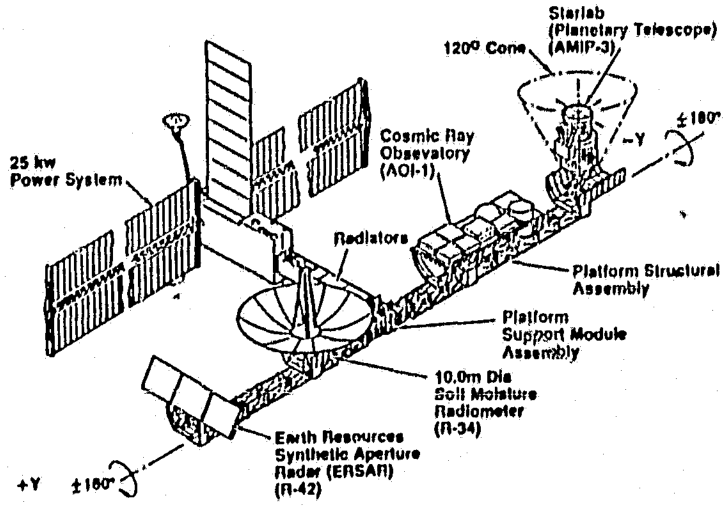


FIGURE 1 PROPOSED SCIENCE AND APPLICATIONS SPACE PLATFORM

Second Order Platform ($\sim$ 1987)

sink (source) whose temperature level is actively controlled. The thermal design of an instrument which is independent of a common heat sink (source) i.e., a thermal utility, is not the primary subject of this specification. Specific instruments may be identified, however, with temperature limits that are best satisfied by a thermal design that is independent of a common thermal utility.

2.2 Alternative Utility Designs

2.2.1 General Description

The use of temperature-controlled, fluid, heat transport system in thermal contact with an instrument provides a heat sink or source to satisfy the energy balance of the instrument within its specified temperature limits. This equilibrium condition may be achieved with or without the use of tailored radiating surfaces on the instruments and with or without heater power internal to the instrument.

2.2.1.1 Single-Phase Heat Transport Systems

A single-phase heat transport system utilizes a pumped liquid to transfer heat from one or more heat sources to one or more heat sinks. A pressure level must be maintained in the fluid system that will prevent evaporation of the coolant at the temperature levels in the system.

The most significant disadvantage of a single-phase, fluid heat transport system is that the use of the sensible heat of the fluid causes a potentially significant temperature variation in the utility as heat is transferred between individual payloads and the heat transport system. High fluid flow rates will reduce the temperature variation but at the expense of higher pumping power. Pumping power can be reduced by increasing the tube diameter for a fixed mass flow rate of coolant; however, the tube wall to fluid heat transfer coefficient will decrease.

A high pumping power could also result from a fluid mass flow rate that is higher than the minimum required to satisfy

the temperature limit requirements of the instruments. A higher than the minimum required fluid flow rate could result from the use of a temperature controlled, by-pass valve on the system heat rejection station, e.g., space radiator. The by-pass valve would maintain a nearly constant temperature for the fluid returning from the heat rejection station by dividing the flow of fluid between the cold radiator and nearly adiabatic radiator by-pass.

2.2.1.2 Two-Phase Heat Transport Systems

The use of a two-phase, heat transport system, which utilizes the latent heat of the fluid to absorb or reject heat, has the potential for a small temperature variation in the utility over a wide range of heat exchange rates between the utility and payloads. Pumping power for the two-phase system will be less than for the single-phase system because of the smaller mass of two-phase coolant that has to be circulated to absorb and reject the maximum system level heat loads. The use of a controlled by-pass valve on the system heat rejection station, e.g., space radiator, to insure a subcooled fluid at a pump inlet may still be required. In a pumped, two-phase heat transport system the vapor and liquid phases move through the system in a single tube in the same direction. Figure 2 is a schematic drawing of a pumped, two-phase heat transport system.

A two-phase, heat transport system based on heat pipes uses capillary pumping to distribute the fluid throughout the system. Capillary pumping can transfer fluid from heat sinks (condensers) to heat sources (evaporators) with no external pumping power. The distance over which a given flow rate of fluid can be moved by capillary pumping is a function of fluid properties, wick geometry, pipe size and the gravity field. A higher heat transport rate for a given fluid and pipe design requires a larger mass flow rate of fluid to be pumped by the capillary action and reduces the maximum distance that can separate the evaporator and condenser sections. Heat pipes

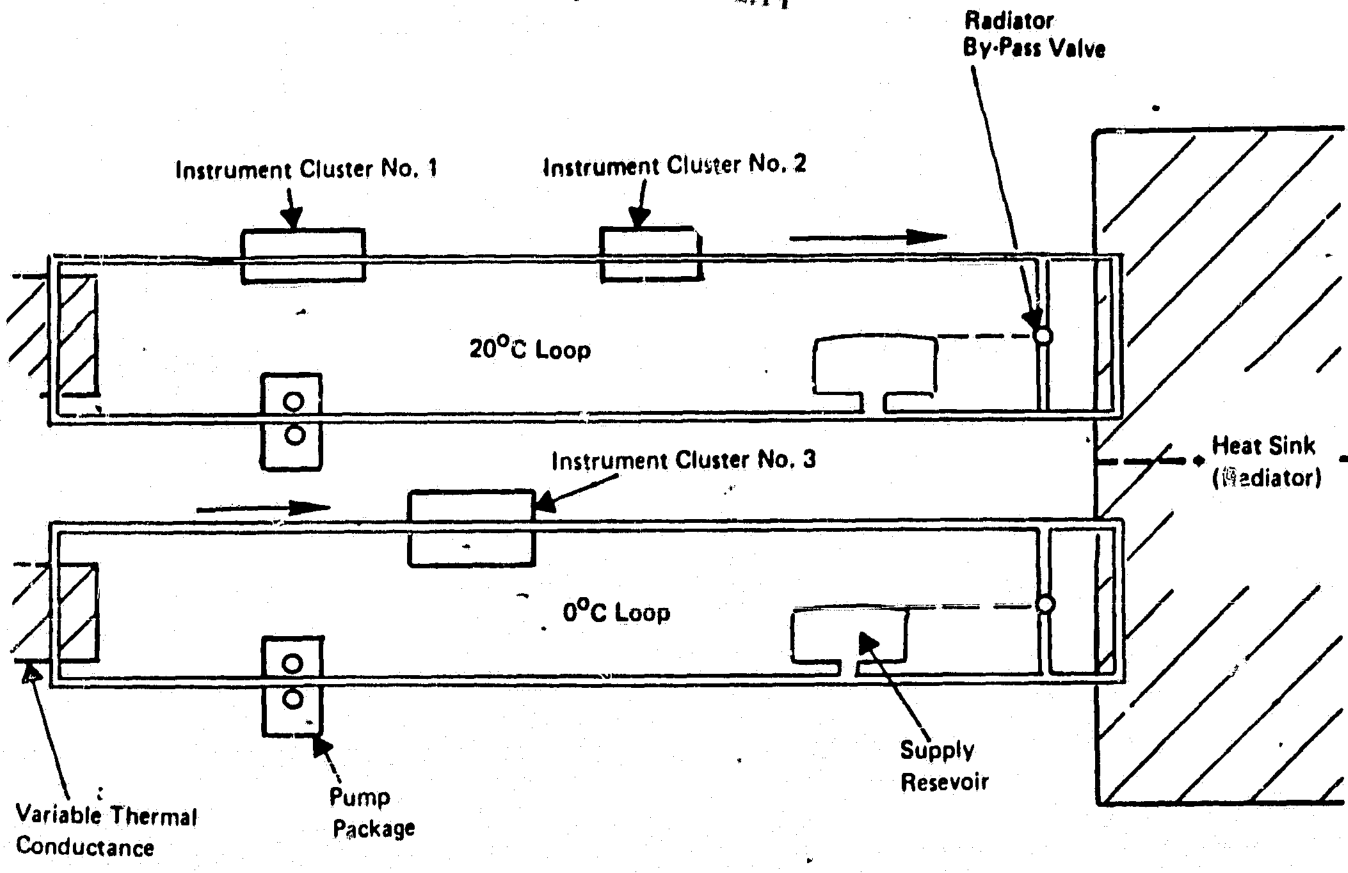


FIGURE 2 SCHEMATIC OF A PUMPED TWO-PHASE INSTRUMENT MODULE THERMAL UTILITY SYSTEM

C-2

have a limited capability to pump liquid against a gravity head. In a conventional heat pipe system the liquid and vapor phases move in opposite directions in the same tube. The two phases, however, do not have to be in the same tube length, i.e., the liquid and vapor could be in separate pipes.

2.3 Basis for Comparison of Alternative Two-Phase Systems

The initial comparison of the two alternative, heat transport systems is based on an assessment of the capability of each system to independently satisfy the thermal requirements of specified instruments over a desired on-orbit lifetime of 5 to 10 years. As a later step the comparison could be expanded to include a third, hybrid system, which incorporates both heat pipes and a pumped two-phase loop.

As a basis for these comparisons, thirteen specific instruments have been identified and grouped into four independent modules or pallets. The particular combination of real and fictitious instruments for this specification was based on the need to have a range of thermal characteristics and not on potential flight candidates. The grouping of the instruments into modules was done by combining payloads having similar scientific requirements, e.g., solar, stellar, or earth viewing. Table 1 identifies the names of the thirteen specific instruments chosen for this study and Table 2 specifies the thermal requirements of these instruments.

3.0 DESCRIPTION OF SYSTEM:

3.1 General

The two-phase, high capacity, heat transport system is to provide a temperature controlled heat sink for the thirteen, specified instruments. If feasible, the same utility should serve as a heat source for some of the same payloads for some of the time. Because the operation of each individual instrument is independent of the operational status of all other instruments, the thermal utility must be able to handle the thermal loads of all combinations of operating and non-operating instruments.

TABLE 1 DEFINITION OF INSTRUMENTS FOR THE HIGH CAPACITY INSTRUMENT MODULE HEAT TRANSPORT SYSTEM[1]

- MODULE NO. 1 - EARTH ORIENTED
  - Instruments No. 1 and 4 are typical of earth sensors, e.g., Thermatic Mapper, Fraunhofer Line Discriminator, Microwave Limb Sounder, Etc.
  - Instrument No. 2 is the measurement of air pollution from Shuttle
  - Instrument No. 3 is the earth radiation budget experiment
- MODULE NO. 2 - MATERIALS PROCESSING AND PLANT GROWTH
  - Instruments No. 1 and 2 are high power materials processing experiments
  - Instrument No. 3 is a plant growth experiment
- MODULE NO. 3 - SOLAR/STELLAR ORIENTED
  - Instrument No. 1 is the solar ultraviolet spectral irradiance monitor
  - Instrument No. 3 is fictional and is called the Stellar Telescope Array
  - Instrument No. 3 is based on the active cavity radiometer
  - Instrument No. 4 is fictional and is called the Deep Space Noise Monitor
- MODULE NO. 4 - EARTH ORIENTED
  - Instrument No. 1 is the ice and climate experiment
  - Instrument No. 2 is the imaging spectrometric observatory

[1] The particular choice of instruments for this study was based solely on the need to have a range of thermal characteristics and not on potential flight candidates.

TABLE 2

DETAILED INSTRUMENT THERMAL REQUIREMENTS

Module Designation and Instrument No.	Temperature Requirements (°C)		Effective Absorbed Environmental Fluxes (watts)		Effective Heat Loss to Space (watts)		Orbit Average Power Dissipation (watts)		Peak Power Dissipation			Heater Power Available (watts)	NOTES- Additional Information and Requirements
	Operating	Non-Operating	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Watts	Minutes	No. Times Per Orbit		
MODULE #1													Radiators and heat leaks on this module are all fixed area. Heat loss to space is a function of temperatures.
Instrument 1	10 to 20	5 to 35	300	100	150	100	300	200	500	10	2	50	
Instrument 2	10 to 30	0 to 40	50	0	200	150	100	100	100			15	
Instrument 3	10 to 30	0 to 40	100	10	150	110	65	45	115	15	1	30	
Instrument 4	20 to 60	0 to 60	40	0	10	0	500	400	700	60	1	20	
MODULE #2													Radiator area for Instruments 1 & 2 are selectable by command. Instrument 3 is fixed area.
Instrument 1	15 to 25	5 to 40	500	100	1600	400	1500	100	1500			50	
Instrument 2	15 to 25	5 to 40	1000	300	3500	800	4000	200	4000			100	
Instrument 3	15 to 25	15 to 25	50	0	50	0	25		25			25	
MODULE #3													Radiators and heat leaks on this module are all fixed area. Heat loss to space is a function of temperature. Instrument #2 has an optical bench 2 meters x 1 meter which must be isothermal to ±1/2°C
Instrument 1	15 to 25	0 to 40	200	125	200	150	320	300	320			50	
Instrument 2	10 to 30	0 to 40	100	0	300	225	150	100	150			75	
Instrument 3	15 to 25	10 to 35	50	10	50	40	15	15	15			5	
Instrument 4	20 to 40	10 to 50	150	100	200	150	50	35	100	30	1	10	
MODULE #4													Radiators and heat leaks on this module are all fixed area. Heat loss to space is a function of temperature.
Instrument 1	20 to 60	-10 to 60	500	100	500	200	2000	200	3000	30	2	100	
Instrument 2	-30 to 35	-40 to 60	350	250	250	70	72	0	72			25	

The heat transferred between an individual instrument and the thermal utility is the net heat flow resulting from an energy balance on the instrument. The other heat flows comprising the total energy balance of an instrument are: 1) internal power dissipation 2) absorbed environmental fluxes including radiative fluxes reflected and emitted by other parts of the total orbiting system and, 3) conductive heat flows between the instrument and any support structure other than the utility interface.

3.2 Centralized vs. Decentralized Design

The thermal utility may have either a centralized or decentralized configuration. A centralized utility thermally connects all instruments on all four modules with either a single or distributed set of radiators. A decentralized utility design is one in which the instruments on each module or pallet have their own thermal utility, including radiators mounted to the pallet, which is independent of the other modules. For this specification the centralized thermal utility configuration should not include the heat rejection radiator of a centralized power system (see Figure 1). This constraint eliminates the requirement for flexible or rotating fluid couplings between a solar oriented centralized power system and other parts of a large space structure to which solar, stellar or earth viewing instrument modules are mounted.

3.3 Utility Temperature Level Set Point

3.3.1 Definition of Temperature Level of Utility

The (local) temperature level of the utility is defined as the (local) temperature of the vapor in the two-phase coolant stream. Other defined temperature locations in the instrument/utility system are: 1) the internal components of an instrument, 2) the utility interface to an instrument and 3) the tube wall. Figure 3 is a simplified drawing of an instrument-utility interface showing the four defined temperature locations.

3.3.2 Considerations for Setting the Temperature Level of the Utility

The temperature level set point(s), chosen for the thermal utility, has a significant impact on the total number of the

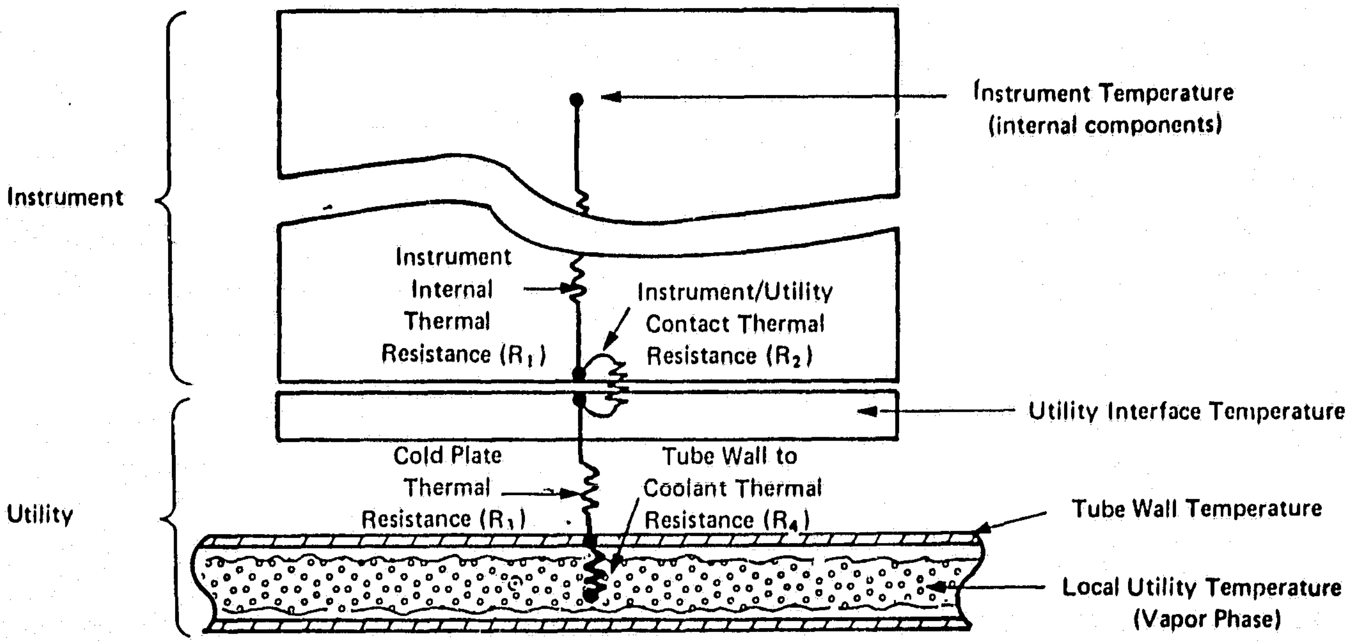
individual payloads whose specified temperature limits can be satisfied by a common utility. The temperature of the utility will vary along its length. When an instrument is rejecting heat into the utility the temperature of the instrument will be above the temperature of the utility. If an instrument accepts heat from the utility, the temperature of the instrument will be below the temperature of the utility. The temperature difference between an instrument and the utility will be dependent on the total amount of heat being exchanged and the thermal resistance between the instrument and the utility.

The internal thermal resistance of the instrument (R_1), the instrument/utility contact thermal resistance (R_2), and the internal thermal resistances of the utility (R_3 and R_4) must all be considered to determine if the specified temperature limits of instrument can be satisfied by the utility. These thermal resistances are identified in Figure 3.

3.3.2.1 Internal Thermal Resistance of an Instrument

The internal thermal resistance of each payload (R_1) and the contact thermal resistance between each payload and the utility (R_2) are not uniquely defined as part of this specification.

Calculations have been made, as a function of the temperature level of the utility, to determine the total allowable thermal resistance between each of the specified instruments and the thermal utility (ΣR) if the thermal utility is to serve as a heat sink for the instrument in its operating and non-operating modes. The assumption is then made that the internal thermal resistance of the instrument (R_1) plus the contact resistance between the instrument and the utility (R_2) is at least 50% of the total allowable thermal resistance (ΣR). This approach defines both an allowable range for the internal thermal resistance of the utility (R_3 plus R_4) at each instrument interface as well as an allowable range for the sum of internal thermal resistance of each payload and the associated contact thermal resistance (R_1 plus R_2) as a function of the temperature level of the utility.



$\Sigma R = R_1 + R_2 + R_3 + R_4$

FIGURE 3 DEFINITION OF TEMPERATURES AND THERMAL RESISTANCES IN TWO-PHASE HEAT TRANSPORT SYSTEM

3.3.2.2 Internal Thermal Resistance of Utility

The total internal thermal resistance of the utility comprises: 1) the resistance of the conductive heat flow path between the utility interface and the tube wall (R_3) and 2) the resistance between the tube wall and the vapor in the two-phase coolant stream (R_4). For this specification the utility interface to tube wall thermal resistance (R_3) is neglected. The internal resistance of the utility at an instrument interface is a specified design parameter.

3.4 Heat Sinks

In addition to the payloads which are exchanging heat with the utility, there is also the need for one or more space radiators to reject the net heat input to the total utility system. The maximum required area of the space radiator is determined by the maximum net amount of heat being rejected by all the payloads, the temperature level of the radiator, the intensity of environmental fluxes incident on the radiator and the optical properties of the radiator.

3.5 Electrical Heater Power

An additional heat input may be required to satisfy the minimum temperature level requirements of some of the instruments for certain combinations of incident environmental fluxes and internal power dissipations. The total heater power required can be reduced if the thermal utility can serve as a heat source for some or all of the payloads when they require heater power. With the utility serving as a heat source, the heat being rejected by one or more upstream payloads could be used to replace some or all of the electrical heater power required by downstream instruments. For the utility to serve as a heat source for a specific instrument, the temperature of the utility must be above the temperature of that instrument. Typically for the thermal utility to be able to serve as a heat sink and as a heat source for a particular instrument (at different times), the total thermal resistance between the instrument and the utility (ΣR) must be small.

3.6 Transient Operation

Variations in the operation of the thermal utility will be caused by any duty cycling and the on/off status of the payloads and by changes in the environmental fluxes absorbed by the payloads and by the radiator(s). The utility and its control system must be able to respond to these transient and steady state thermal loads with a small temperature variation in the utility. Depending on the operating characteristics of the utility, the short term peak loads of each instrument may or may not produce a steady state thermal condition in the utility.

3.7 Control System

A system is required to control the thermal utility so as to provide the specified utility temperature level for all operating and environmental conditions. Pressure level, pump speed, the location of the liquid inventory, the location and the amount of heater power the setting of the radiator by-pass valve and/or the amount of active radiating area are several system level parameters that could be controlled.

3.8 Lifetime

For space platform applications an on-orbit lifetime of 5 to 10 years for the thermal utility is a design goal. Redundancy of components and/or on-orbit maintenance or replacement are design options.

3.9 Operation in a 1-g Gravity Field

Because the performance of the thermal utility may be tested on earth prior to launch, it is necessary that the system be capable of operating in a 1-g field. A reduction in system performance limits from those obtainable in a 0 gravity field is acceptable if the test results obtained in a 1-g field can be extrapolated to operation in a 0-g field with confidence.

3.10 Choice of Coolant

The choice of coolant for the two-phase system will affect the heat transport and pressure drop characteristics of the thermal

utility. In addition, the toxicity of the coolant to humans, and its vapor pressure from the freezing point up to 125°C must be defined.

3.11 Definition of System Components

In addition to the basic components of the thermal utility, e.g. pumps, heat pipes and smooth or extended interior surface tubes, there may be a requirement for other items of hardware. These other items of hardware may include quick disconnect fluid connections, valves, accumulators, heat exchangers and quality, temperature or pressure sensors. The requirement for additional items of hardware for the thermal utility may be different for a centralized or a decentralized system configuration.

4.0 SYSTEM SPECIFICATIONS:

4.1 General

There are thirteen instruments to be thermally coupled into the proposed utility. Table No. 1 lists the assigned names of the instruments and shows how the instruments have been arranged into four independent modules or pallets.

4.2 Centralized vs. Decentralized Utility Configuration

In a centralized configuration, the individual pallets can be adjacent to each other or separated from the nearest pallet by a maximum distance of 15 meters. The length of a single pallet is approximately 3 meters and the vertical distance from the bottom inner pallet skin panel to its sill is approximately 2 meters. Figure 4 is a dimensional drawing of a pallet.

A utility circular length of 100 meters (50 meters end to end) is specified for a centralized design and a utility end to end length of 10 meters is specified for a decentralized design.

4.3 Temperature Level Requirements of Payloads

Table 2 summarizes the detailed thermal requirements of the thirteen instruments showing the specified operating and non-operating

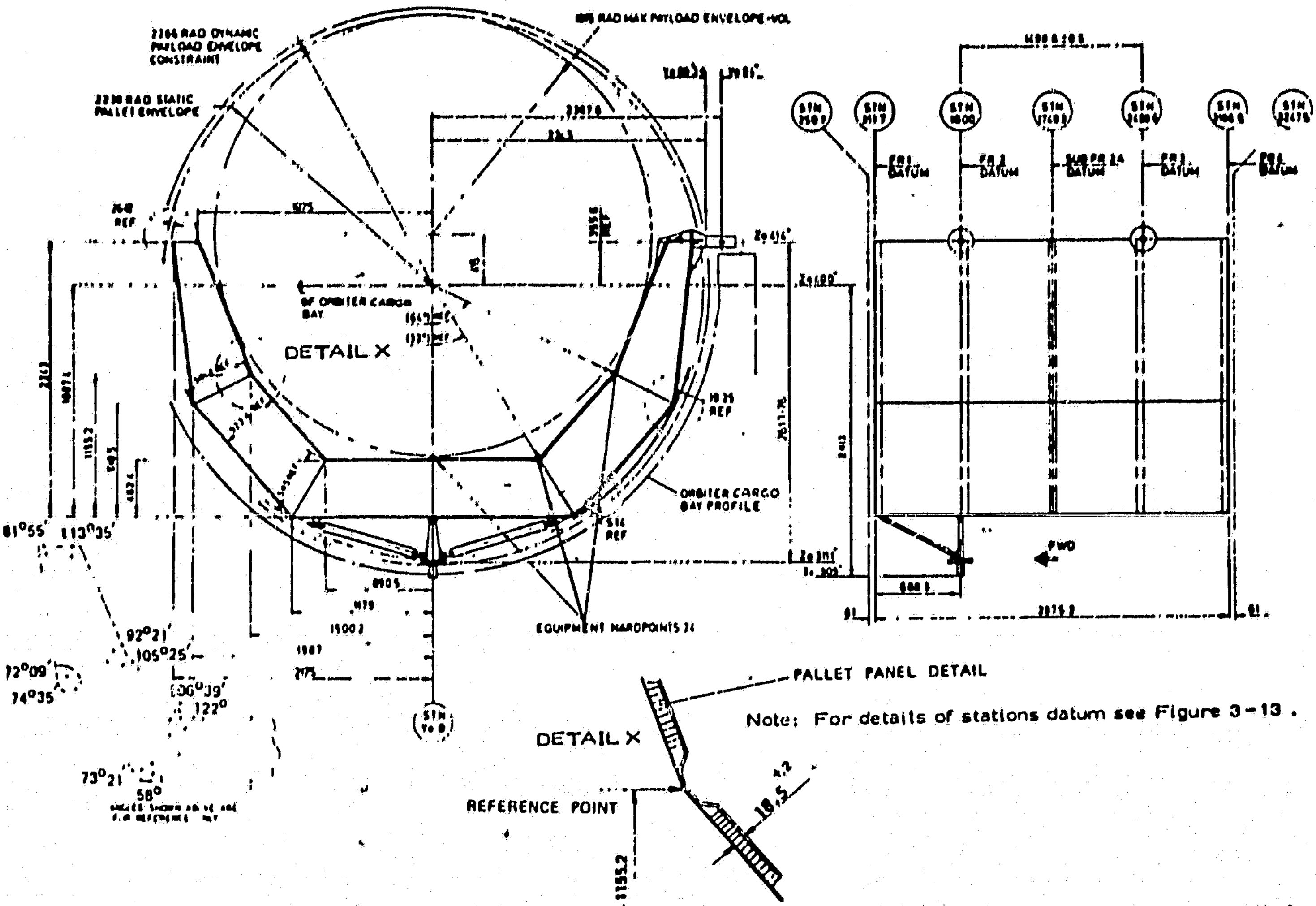


FIGURE 4 DIMENSIONAL DRAWING OF PALLET

payload temperature limits as well as peak, maximum and minimum internal power dissipations. Maximum and minimum absorbed environmental fluxes and maximum and minimum heat losses to space by each instrument are also defined by Table 2.

For utility set point temperatures of approximately 13°C, 18°C and 23°C and end-to-end temperature variations of ±1°C, ±5°C and ±10°C, a utility/instrument cold plate must be designed having an internal thermal resistance of 0.002, °C/W.

The design of the thermal utility interface cold plate must include the tube geometry and an area for the mounting interface of each instrument so that the internal thermal resistance of the utility can be packaged within the area of the interface. For design purposes only a single layer of coolant tubing can be contained within the area of the instrument interface and the thermal resistance between the coolant tube wall and the instrument mounting interface can be neglected.

4.4 Heat Sink

Based on the data defined in Table 2, the range of net heat exchange rates between all instruments and the utility has been calculated and is shown in Table 3. The peak operating power levels may be a transient or a steady state thermal condition for the thermal utility depending on the operating characteristics of the utility. The duration of the peak power level is defined in Table 2. The heat rejection radiator of the thermal utility must be able to reject all other (non-peak) heat exchange rates as defined in Table 3 as an equilibrium thermal condition.

4.4.1 Incident Environmental Flux Intensities

The amount of heat to be rejected by the radiator comprises the heat absorbed by the utility from the instruments and any associated pumping power plus the environmental fluxes absorbed directly by the radiator. Other environmental heat flows into or out of the utility are neglected for this specification. The environmental flux intensities normally incident on one

TABLE 3

SUMMARY OF PEAK AND ORBITAL AVERAGED HEAT FLOWS (WATTS) BETWEEN CANDIDATE PAYLOADS AND THERMAL UTILITY

- **Heat Rejection by Local Radiators included for Materials Processing Experiments Only**

Instrument Status:	Operating			Non-Operating[1]	
Power Level:	Peak	Maximum	Maximum	Minimum	Minimum
Environment Fluxes:	Maximum	Maximum	Minimum	Maximum	Minimum
Heat Loss to Space	Minimum	Minimum	Maximum	Minimum	Maximum
MODULE NO. 1					
Instrument 1	700	500	250	400	150
Instrument 2	0	0	-100	0	-100
Instrument 3	105	55	-75	35	-95
Instrument 4	740	540	490	440	390
	1,545	1,095	565	875	345
MODULE NO. 2					
Instrument 1	400[2]	400[2]	0	200	-200[3]
Instrument 2	1,500[2]	1,500[2]	800	400	-300[3]
Instrument 3	75	75	-25	75	-25
	1,975	1,975	775	675	-525
MODULE NO. 3					
Instrument 1	370	370	245	350	225
Instrument 2	25	25	-150	-25	-200
Instrument 3	25	25	-25	25	-25
Instrument 4	100	50	-50	35	-65
	520	470	20	385	-65
MODULE NO. 4					
Instrument 1	3,300	2,300	1,600	500	-200
Instrument 2	352	352	72	280	0
	3,652	2,652	1,672	780	-200
TOTAL	7,692	6,192	3,032	2,715	-445

1. No heater power has been added to Instruments.
2. Maximum power dissipation coincides with maximum heat rejection for materials processing experiments via local radiators.
3. Minimum power dissipation coincides with minimum heat rejection for materials processing experiments.

side of a radiator are 1360 watts/m^2 in the UV and 22 watts/m^2 in the IR. There is no environmental flux incident on the other side of the radiator at the same time. If more than one radiator is utilized, the projected area of each radiator to the incident flux can be computed assuming that the flux is normal to the largest single radiator.

4.4.2 Radiator Optical Properties

Each planar radiator is covered with silverized teflon on all radiating surfaces (α=.1, ϵ =.76).

4.4.3 Active Control of Radiating Area

A control system to actively vary the effective radiating area of a radiator, or to vary the number of radiators thermally connected to the utility in response to the heat rejection rates of the system, can be considered as part of the system design.

4.5 Heater Power

This specification does not require the definition of heater power requirements for individual instruments. Any requirement for heater power on the thermal utility must be specified.

4.6 Transient Operation of the Utility

The important parameters of the thermal utility during a period of transient operation are: 1) utility temperature level, 2) instrument interface or radiator heat exchange limits and 3) the time constant of the transient. The transient response of the thermal utility is to be determined for an approximately 18°C temperature level of the utility and for a specified utility internal interface resistance of 0.002 °C/W at each instrument. The following transient conditions are to be analyzed for both a centralized and a decentralized design:

1. Turn-on of the single instrument having the highest operating heat rejection rate to the utility with all other instruments in a non-operating status and with minimum environmental fluxes and maximum heat losses to space for all instruments.

2. Turn-on of a single module having the highest operating heat rejection rate to the utility with all other instruments in a non-operating status and with minimum environmental fluxes and maximum heat losses to space for all non-operating instruments. The instruments in the module being turned on will have a step change to a condition of peak internal power dissipation, maximum environmental fluxes and minimum heat loss to space at the time of turn-on.

3. All thirteen instruments change from a maximum heat rejection to utility operational status to a non-operational status with maximum environmental fluxes and minimum heat losses to space.

4.7 Control System

Because of the variation in the heat exchange rates with the payloads, there are many different operating states for the thermal utility. A control system to maintain the desired temperature level in the utility while managing liquid inventory and flow rates through the radiator and/or active radiating area, is required. The operating principle(s) and components of the control system are to be defined.

4.8 Lifetime

A lifetime of 5 to 10 years on-orbit is the design goal. Based on available data, the expected reliability of each component should be defined after 5 and 10 years on orbit. For each utility design it must be determined whether an improved reliability for 5 to 10 years on orbit can be better achieved using redundant components or with on-orbit maintenance.

4.9 Operations in a Gravity Field

The heat rejection and temperature level capabilities of any proposed thermal utility design are to be determined when the utility is operating in a 1-g environment with all heat inputs being 1 meter above the heat rejection station. If the utility design cannot operate over a vertical distance of 1 meter in a gravity field, the heat exchange rate and height limits must be defined for operation in the 1-g field.

4.10 Choice of Coolant

One or more candidate coolant(s) must be identified for use with any proposed two-phase heat transport system. The toxicity to humans and vapor pressure curve from the freezing point up to 125°C must be defined for each candidate coolant. The steady state and transient performance of the system shall be calculated for at least one coolant chosen by the system designer to optimize the performance of the system for all specified operating and non-operating conditions including performance in a 1-g field. Toxicity to humans shall not be a factor in choosing a coolant for this specification.

4.11 Definition of System Components

A schematic drawing shall be made of the baseline thermal utility to identify all components of the system. The need for special valves, fluid connectors, pumps, heat exchangers, accumulators, sensors, control electronics, or tubes of special geometries shall be identified on the drawing. The power consumption of the operating system and the total mass of the system shall be calculated for each proposed utility design. A radiator mass of 5.0 kg/m^2 (1.0 lbm/ft^2) shall be used. The mass of the utility interface to each instrument shall consist of the mass of the required length of coolant tubing plus an additional mass of 20.0 kg/m^2 for the remainder of the interface thermal and mechanical structure.

4.12 Summary of Design Parameters

Table 4 is a summary of the design parameters for the two-phase high capacity heat transport system.

5.0 REQUIRED OUTPUTS:

5.1 General

The outputs from this study basically comprise results from the parametric trade studies plus the preliminary design and operational characteristics of at least one preferred, baseline thermal utility. (centralized or decentralized). Tables 5 and 6 summarize the required outputs.

TABLE 4 SUMMARY OF INPUT DESIGN PARAMETERS FOR A HIGH CAPACITY HEAT TRANSPORT SYSTEM

Parameter	Range of Design Values
System Length - Centralized	100 m (50m end to end)
- Decentralized	20 m (10m end to end)
Utility Temperature Level Set Points	13, 18, 23 (°C)
Utility Temperature Variation along Length	±1, ±5, ±10 (°C)
Internal Thermal Resistance of Utility at an Instrument Interface	0.002 (°C/W)
Environmental Fluxes Incident on Radiator	UV 1360 W/m^2 IR 22 W/m^2
Radiator Mass/Area	5.0 kg/m^2
Instrument Interface Mass/Area (not including coolant tubing)	20.0 kg/m^2
Gravity Field	0- and 1-g
Change in System Elevation for Operation in 1-g Field	1m

5.2 Results from Parametric Trade Studies

The required results from the parametric trade studies are defined in Table 5.

5.3 Definition of Baseline Design

The minimum required outputs from a definition of a baseline utility design are defined in Table 6.

TABLE 5 SUMMARY OF REQUIRED OUTPUTS FROM PARAMETRIC STUDIES

1. Choice of coolant.
2. Transfer pipe geometry including mass per unit length.
3. Instrument/utility interface pipe geometry.
4. Area and total mass of instrument/utility interface plate.
5. Definition of control philosophy.
6. Definition of system components.
7. Copy of all calculations.

TABLE 6 SUMMARY OF REQUIRED OUTPUTS FROM BASELINE DESIGN

1. Schematic drawing of thermal utility identifying all components
2. Choice of coolant.
3. Total mass of thermal utility without coolant.
4. Total mass of coolant.
5. Total power consumption of utility (neglecting any instrument heater power).
6. Steady state and transient temperature level and heat rejection capabilities of operating system.
7. Capability of system to operate in a 1-g field (up to 1 m change in elevation).
8. Copy of all calculations.

APPENDIX C

ANALYSIS OF CAPABILITIES OF PTP/HTS

APPENDIX C
ANALYSIS OF CAPABILITIES OF PTP/HTS

1.0 SYSTEM

A fundamental element of the PTP/HTS is illustrated in Figure C-1. It consists of a channel carrying a fluid in a vapor-liquid, two-phase mixture to which heat is added or extracted. The heat transfer to or from the fluid involves a change in phase, evaporation at the evaporator section and condensation at the condenser section. The vapor and liquid phases flow in the same direction in the channel and a pressure drop in the direction of flow occurs due to wall shear and momentum change accompanying vaporization or condensation. Flow is supplied to the channel in a saturated state and in an amount which insures that, for the given heat addition or extraction, two phases will persist, that is, the quality of the flowing mixture will remain between unity and zero. The pressure drop along the channel is set at some allowable limit by determining an appropriate cross-sectional area (or channel diameter). The allowable pressure drop limit is set by the allowable temperature drop of the bulk fluid which, in turn, is set by requirements of the thermal control system. The pressure drop and temperature drop of the flowing mixture are essentially in thermal equilibrium at saturated conditions and, hence, their ratio is fixed at a value dependent on the particular saturation properties of the working fluid.

For the thermal control application of interest, the evaporator and condenser sections can be considered heat stations for the instrument modules. Of course, a particular heat station may act either as a condenser or evaporator. The allowable pressure drop (allowable temperature drop) and the mass flow rate establish the power requirements to circulate the fluid. The complete system involves a closed loop in which the two-phase mixture is reduced to a single-phase liquid prior to reaching the pump, to minimize hydraulic pumping power requirements.

The selection of the channel size or pipe diameter for a given maximum value of heat exchange, Q_{max}, involves a trade-off among the heat transport length, L, the size and weight and installation difficulties associated with pipe size, and the flow regime at which the two-phase mixture operates. The flow regime most appropriate to the PTP/HTS is a stratified one in a unit-gravity field, but it is essentially one having low velocities and low shear stresses. These conditions can be realized in the applications of interest with pipe diameters less than 0.0254 m (1.0 in.). The flow limit for stratified or stratified-wavy flow regimes to exist at all flow qualities for R717 at 20°C, as predicted by the Baker[1] diagram, is shown in Figure C-2.

2.0 ANALYSIS

2.1 Adiabatic Section

In the adiabatic section of the pipe flow, a horizontal pipe and stratified flow with a flowing mixture of quality y is assumed. Under 1-g conditions the liquid

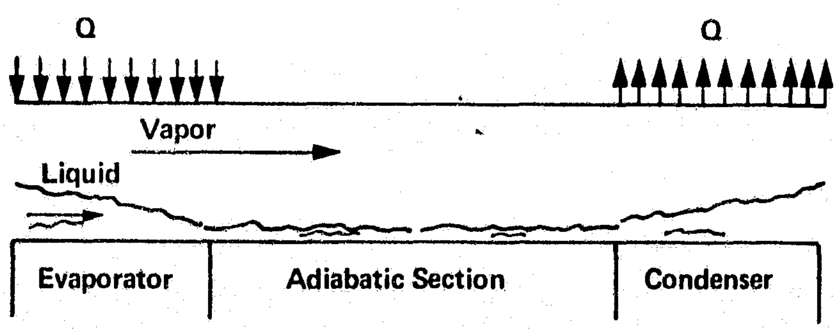
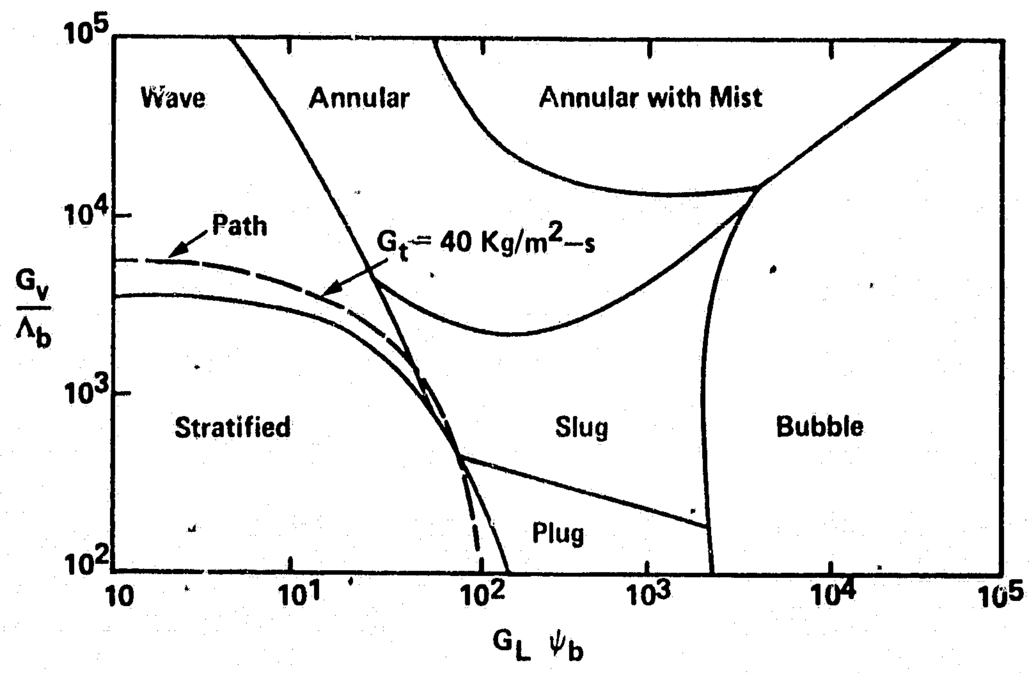


FIGURE C-1 PTP/HTS FUNDAMENTAL ELEMENTS



BAKER DIAGRAM

FIGURE C-2 FLOW REGIMES FOR EVAPORATION/CONDENSATION OF R717

flows along the bottom of the pipe with the vapor above it. For the vapor to pass along the pipe, its velocity must, in general, be greater than that of the liquid because its density is much smaller. The pressure drop and the shear stress at the vapor-liquid interface drives the liquid in balance with the shear stress at the liquid-wall boundary. The following assumptions are made:

- The pressure drops in the liquid and vapor phases are identical.
- The vapor flow is turbulent.
- The liquid flow is laminar.
- The flow in a pipe of constant cross-section is steady.

In principle, the Lockhart and Martinelli[2] correlations would apply to this case. However, these correlations involve empirical data for flow regimes not explicitly stated. Other correlations such as that of Chisholm[3] have similar limitations. The simple, homogeneous, no-slip model of two-phase flow is obviously violated. Because of these limitations, the following analysis was developed.

For the conditions stated, the momentum equation applied to the liquid layer between two axial stations is (see Section C-5.0, Nomenclature)

$$\tau_s A_s - \tau_o A_{\ell w} = -\Delta P_v A_{\ell c} \qquad \text{(C-1)}$$

Assume a velocity distribution in the liquid layer of the form

$$V_{\ell y} = by + cy^2 \qquad \text{(C-2)}$$

$$V_\ell = \frac{\int_o^s V_{\ell y}\, dy}{s} = \frac{bs}{2} + \frac{cs^2}{3} \qquad \text{(C-2a)}$$

$$\left.\frac{\partial V_{\ell y}}{\partial y}\right|_{y=o} = b; \qquad \left.\frac{\partial V_{\ell y}}{\partial y}\right|_{y=s} = b + 2\,cs \qquad \text{(C-2b)}$$

$$\mu_\ell \left.\frac{\partial V_{\ell y}}{\partial y}\right|_{y=o} = \tau_o \qquad \text{(C-3)}$$

$$\mu_\ell \left.\frac{\partial V_{\ell y}}{\partial y}\right|_{y=s} = \tau_s \qquad \text{(C-3a)}$$

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By definition

$$\frac{D_\ell}{4L} = \frac{A_{\ell c}}{A_{\ell w}} \tag{C-4}$$

$$\frac{D_v}{4L} = \frac{A_{vc}}{A_{vw}} \tag{C-4a}$$

Further assume, for $V_\ell/V_v << 1$, that A_{vw} is the total area wetted by the vapor flow, including the interface with the liquid.

The momentum equation applied to the gas combined with the conventional definition of friction factor gives

$$\Delta P_v = 2f_v \frac{L}{D_v} \frac{\rho_v V_v^2}{g_o} \tag{C-5}$$

By combining equations C-1 through C-5 simultaneously, one can solve for the coefficients b and c:

$$b = \frac{f_v \rho_v V_v^2}{2g_o \mu_\ell} \left(\frac{D_\ell}{D_v} + \alpha \right) \tag{C-6}$$

$$c = -\frac{f_v \rho_v V_v^2}{4g_o \mu_\ell s} \left(\frac{D_\ell}{D_v} - 1 + \alpha \right) \tag{C-6a}$$

and

$$V_\ell = \frac{f_v \rho_v V_v^2 s}{2g_o \mu_\ell} \left(\frac{1}{3} \frac{D_\ell}{D_v} + \frac{1}{3} \alpha + \frac{1}{6} \right) \tag{C-7}$$

$$V_v = \frac{wy}{\rho_v A_i \phi} = \frac{G_t}{\rho_v} \frac{y}{\phi} \tag{C-8}$$

$$\frac{V_\ell}{V_v} = \frac{f_v G_t y s}{2g_o \mu_\ell \phi} \left(\frac{1}{3} \frac{D_\ell}{D_v} + \frac{1}{3} \alpha + \frac{1}{6} \right). \tag{C-9}$$

but, by the definitions of y and ϕ

$$\frac{V_\ell}{V_v} = \frac{\rho_v}{\rho_\ell} \left(\frac{1-y}{y} \right) \left(\frac{\phi}{1-\phi} \right) \tag{C-10}$$

where the liquid layer has a variable thickness, we choose an average value for s defined by

$$S = \frac{2A_{\ell c}}{p} \tag{C-11}$$

Equations C-9 and C-10 provide the basis for the solution to the problem. The procedure is as follows: Select a fluid, a value of w/A_i, and the spatial distribution of the liquid in the channel (for instance, the value of h/D_i or θ for liquid in a horizontal pipe). Further, choose a value of f_v appropriate to turbulent flow. This value can be refined, if necessary, by iteration of the solution process. Equations C-9 and C-10 combine to form a quadratic equation in y with solution:

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$$y = \frac{-1 + \sqrt{1 + \dfrac{4BD_i}{C}}}{\dfrac{2BD_i}{C}} \tag{C-12}$$

where:

$$B = \frac{f_v G_t}{2g_o \mu_\ell} \left(\frac{1}{3} \frac{D_\ell}{D_v} + \frac{1}{3} \alpha + \frac{1}{6} \right)$$

$$C = \frac{\rho_v \phi^2 D_i}{\rho_\ell (1 - \phi) s}$$

Having determined y, then, V_v is determined from Equation C-8 and $\Delta P_v/L$ is determined from Equation C-5.

A solution thus arrived at is shown in Figure C-3. A comparison between the theoretically predicted pressure drop and that measured in a laboratory test is illustrated in Figure C-4. Martinelli and homogeneous flow correlations are also shown. The Reynolds numbers for the vapor flow range from 5000 to 44000 and less than 1000 for the liquid flow at a range of y between 1 and 0.1. Therefore, the assumptions of turbulent vapor flow and laminar liquid flow are appropriate. The pressure drop per unit length at a given value of G_t decreases with decreasing value of y. The maximum pressure drop occurs for $y = 1$ or for vapor flow only. As the average vapor fraction in the evaporator section is less than that in the following adiabatic section and is greater in the condenser following the adiabatic section, one can say the pressure drop per unit length in an evaporator is less than that of a following adiabatic section and the pressure drop per unit length in a condenser is less than that in a preceding adiabatic section. This condition applies where the flow proceeds through all sections in a constant-area channel.

A conservative approach would base the heat capacity-heat transport length capabilities of the PTP/HTS on the assumption that the pressure drop results from the total mass flow transported as a vapor. This assumption has been made in the estimates of the PTP/HTS performance.

Under low-gravity circumstances, at the same flow conditions which result in a gravity-stratified flow regime in the earth-gravity environment, the liquid will not flow along the bottom of the flow channel. Rather, the work of Suo and Griffith[4] suggests that either annular or bubble-slug types of flow will exist, depending on

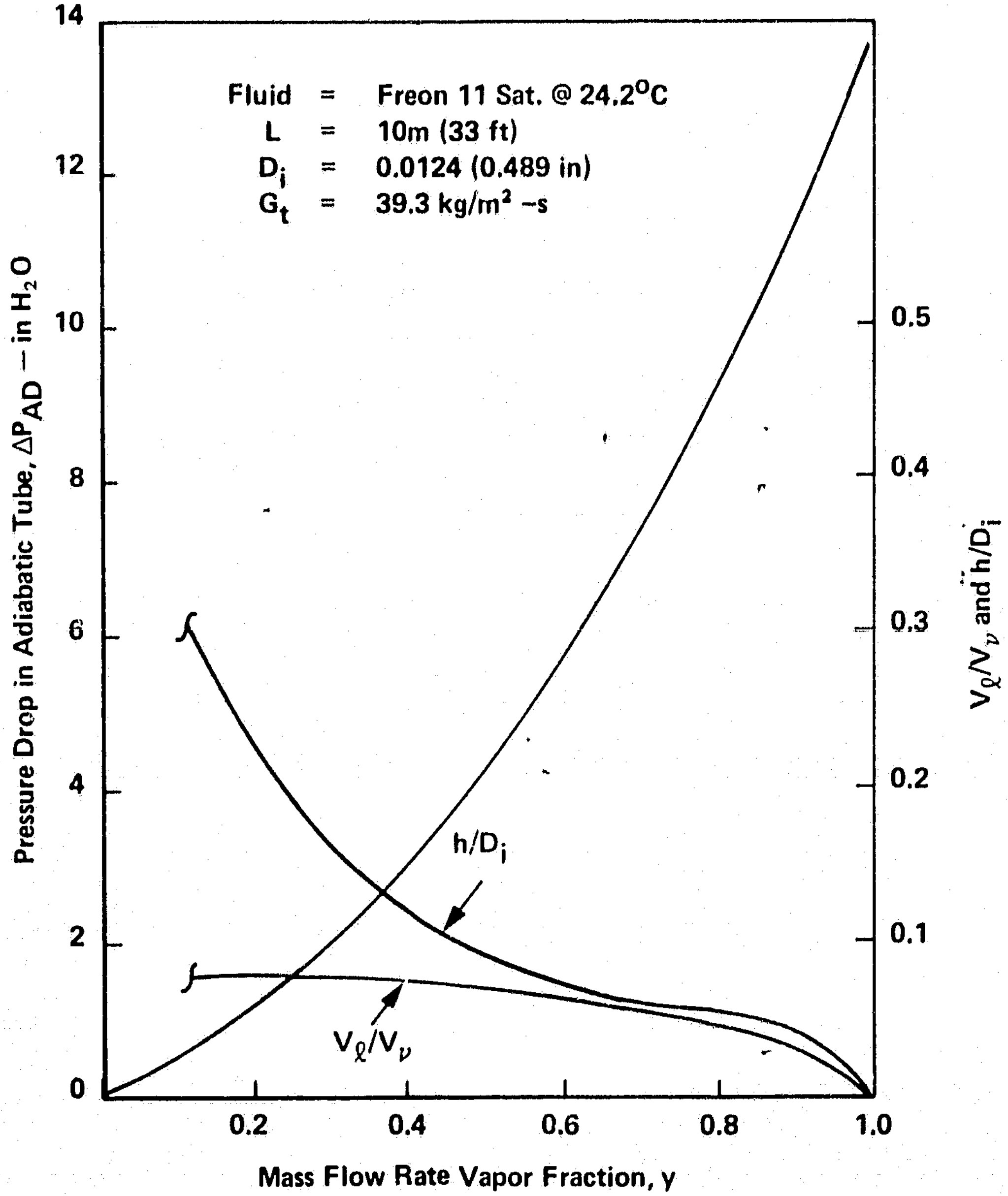

FIGURE C-3 STRATIFIED TWO PHASE FLOW THEORY

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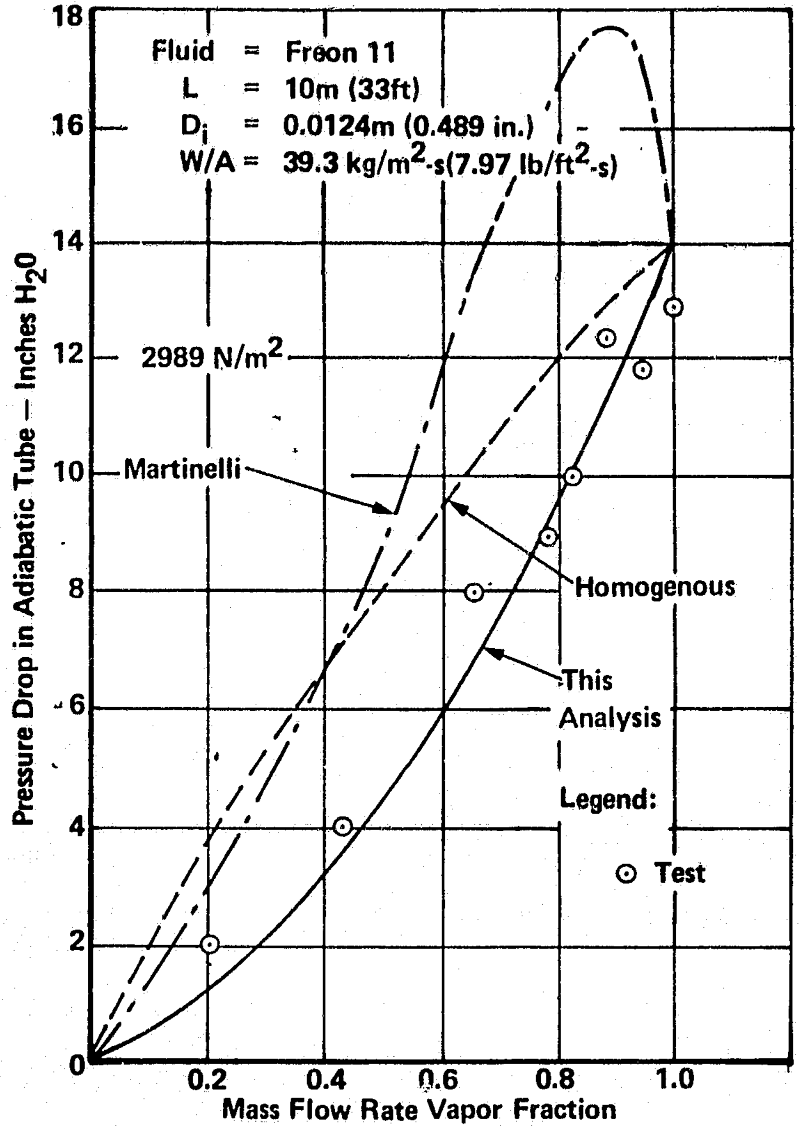

FIGURE C-4 COMPARISONS AMONG TEST AND PREDICTED RESULTS

liquid/gas volume flow ratios. The analysis presented here applies to the case of an adiabatic annular flow, but it would have to be modified to make it applicable to bubble-slug flow circumstances. Finally, it is noted that at 1-g the flow channel must be level for the gravity-stratified model that has been developed. To apply, the inclination of the channel from the horizontal should be small enough to make the difference in hydrostatic pressure over a length small in comparison with the pressure loss due to flow along the same length. For operation at 0-g, there is no such restriction.

3.0 HEAT TRANSFER CONSIDERATIONS

The evaporator section in stratified flow will operate on earth in a forced convection or nucleate boiling regime up to the burnout heat flux rate at all flow qualities somewhat less than unity. The temperature drop between the wall and the bulk fluid will depend on this flux rate, as can be determined by experiments, or as based on a number of correlations (in the absence of experimental data). For instance, the information in References 5, 6, and 7, was used for the design of the evaporator in the test apparatus described in Section 5. The heat transfer coefficients associated with boiling are generally high. However, these heat transfer coefficients are not simply arrived at, since they depend, in general, on the properties of the working fluid, geometry, flow, and heat flux rates.

Boiling, as observed on earth, depends on the gravitational field to remove the bubbles from the heated surface. Also, the liquid must be positioned to wet the heated surface. Siegel and Usiskin[8] reported some nucleate boiling tests made with a heated ribbon in a liquid in free-fall conditions. At 0-g a large vapor volume enveloped the ribbon, suggesting that nucleate boiling was essentially nonexistent. However, at a small level of gravity equal to approximately 0.1-g, they reported nucleate boiling similar to that at 1-g. According to this information, a useful design approach might utilize a tube section with spiralling internal fins. In a low-gravity field, the liquid will position itself in accordance with centrifugal forces against the tube wall between the fins; moreover, surface tension forces acting on the surface web between fins will augment the centrifugal forces. By appropriate fin design this can be made to occur even in a unit-gravity field. By this method, the liquid will not only be positioned but a centrifugal field will allow nucleate boiling to take place. We have estimated that centrifugal force fields of a few tenths of g can easily be produced by this method. In such a system the correlation of B. Pierre,[9] widely used for forced-convective evaporating conditions, might reasonably apply, with a coefficient appropriate to the convective flow of a single-phase liquid being established as a lower limit.

Another approach to an estimate of the change-of-phase heat transfer coefficients would be to adopt the analytical model of Kamotani.[10] This model has proved useful in estimating the heat transfer coefficients for heat pipes with internal fin geometrics. The model is based on pure conduction in the fins and the liquid held between them by capillary forces. This model might apply in regions of flow quality greater than 10 or 20 percent. It applies to both the evaporative and condensing conditions.

Figure C-5 summarizes some estimates of the heat transfer coefficients resulting from application of the B. Pierre and Kamotani correlations. The flow and geometric parameters are selected as typical of those for an instrument-utility cold plate as described in Section 5. Although useful for preliminary design purposes, these estimates of heat transfer coefficients are uncertain. For optimum design, further R&D effort is needed to reduce these uncertainties and produce information for optimum design.

4.0 PERFORMANCE ESTIMATES

The maximum heat capacity of the PTP/HTS is given by

$$Q_{max} = h_{\ell v} \; w = \frac{w}{A_i} \left(\frac{\pi D_i^2}{4}\right) h_{\ell v} \tag{C-13}$$

The heat transport length (essentially that of the adiabatic section) is given by

$$L = \frac{\Delta P_v D_i g_o}{\dfrac{2 f_v}{\rho_v} \left(\dfrac{w}{A_i}\right)^2} \tag{C-14}$$

The allowable limit on ΔP_v is established by the allowable limit on the bulk temperature drop of the saturated mixture, ΔT_s. The transport L calculated by Equation 14 is less than actual because the pressure drop is calculated as if the total mass flow were transported as a vapor when in reality it is transported as a two-phase mixture.

Estimates of the PTP/HTS performance based on application of Equations C-13 and C-14 are shown in Figure C-6. Freon (R11) and anhydrous ammonia (R717) saturated at 24°C were selected as candidate working fluids, and a ΔT_s of 5°C was established as a limit. The value of Q_{max} L is nearly proportional to the selected ΔT_s limit.

These results show the extraordinary potential of the PTP/HTS in the applications discussed. Q_{max} L products in the million watt-meter, or even 10 million watt-meter, range are possible in convenient pipe sizes — less than 0.0254 (1.0 in.) I.D., in the case of ammonia. Q_{max} values in the range of 1 to 10 kW are also possible.

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Heat transfer at one-G after B, Pierre

$$h = 1028\, G \left(\frac{\Delta x}{L} \right)^{1/2} \qquad R_u = \frac{1}{h\, \alpha \pi D L}$$

Δx	h ($W/m^2 - °C$)	R_u (°C/W)
0.01	2374	.0018
0.10	7507	.0006

for: R717

$G = 40 Kg/m^2\text{-}s$
$L = 3$ m
$D = 0.0127$ m
$\alpha = 2$

Heat transfer at zero-G after Kamotani

$$h = \frac{14 k_\ell}{b} = 7000 \text{ W/m-°C}$$

$$R_u = \frac{1}{h \alpha' \pi D L} = 0.0015$$

for: R717

$k_\ell = 0.494$ W/m-°C

$b = 10^{-3}$ m

$\alpha' = 0.8$

FIGURE C-5 ESTIMATES TO TWO-PHASE HEAT TRANSFER COEFFICIENTS

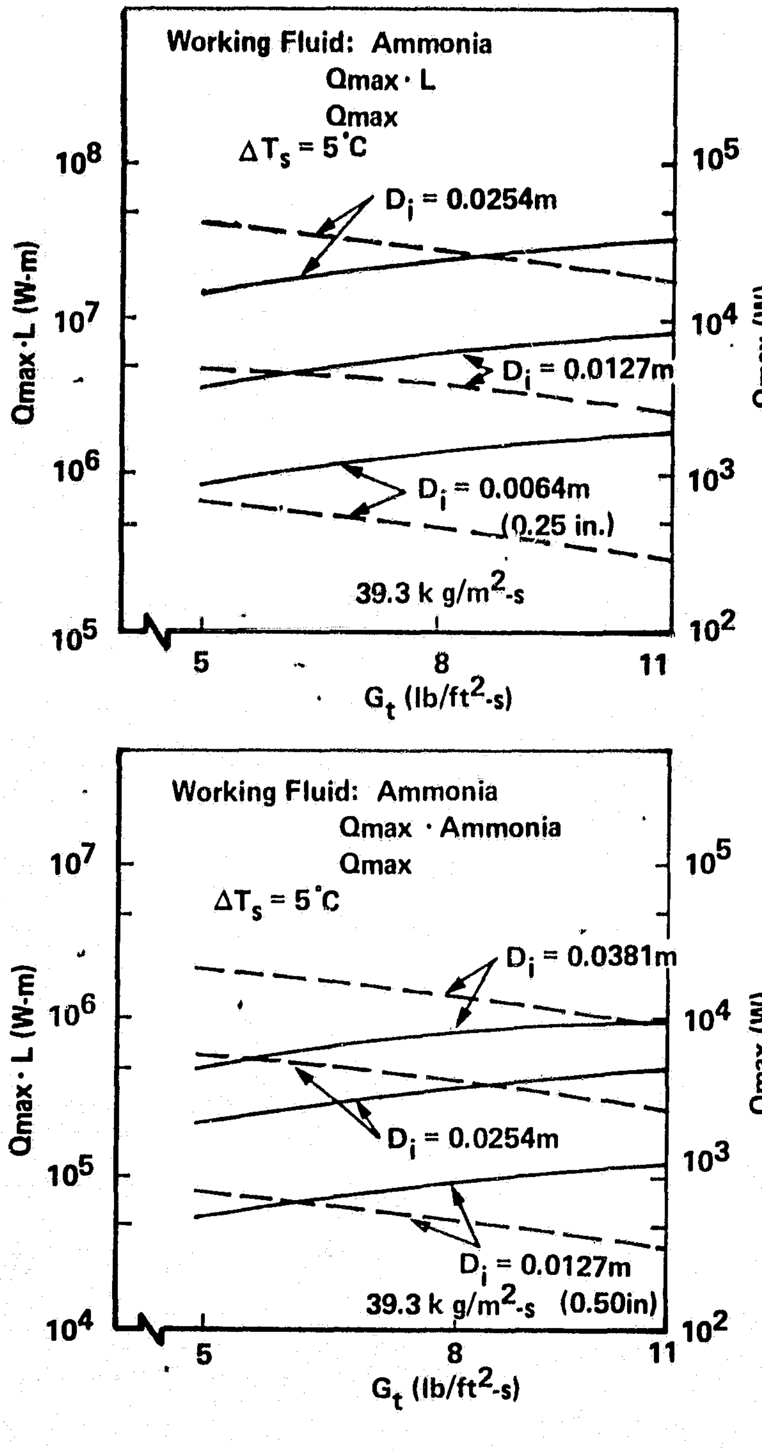

FIGURE C-6 HEAT TRANSPORT CHARACTERISTICS

Finally, the ideal (reversible adiabatic) power required to circulate the fluid is given by

$$IP = \frac{w\,\Delta P_v}{\rho_\ell} = \frac{Q_{max}\,\Delta P_v}{\rho_\ell h_{\ell v}} \qquad \text{(C-15)}$$

The ideal pumping power for Freon (R11) and ammonia are $6.29 \times 10^{-5} Q_{max}$ and $1.90 \times 10^{-4} Q_{max}$, respectively, showing that the ideal pumping power for fluid circulation is negligible. The actual power will be set by mechanical pump losses and electric power conversion inefficiencies, but will not exceed 10 watts for the range of applications shown in Figure C-6.

5.0 NOMENCLATURE

A_i	— cross-sectional area of pipe
$A_{\ell c}$	— cross-sectional area of liquid flow
$A_{\ell w}$	— wetted area between liquid and wall
A_s	— area of vapor-liquid interface
A_{vc}	— cross-sectional area of vapor flow
A_{vw}	— total area wetted by vapor flow
B	— parameter
b	— coefficient in polynomial expression
C	— parameter
c	— coefficient in polynomial expression
D_i	— inside diameter
D_ℓ	— hydraulic diameter of liquid flow
D_v	— hydraulic diameter of vapor flow
f_v	— friction factor for vapor flow
G_t	— mass flow rate per unit area
g_o	— standard gravity constant
h	— maximum thickness of liquid layer in bottom of pipe
$h_{\ell v}$	— latent heat of vaporization
L	— length
N_R	— Reynolds number
P	— pressure
P_s	— saturation pressure
ΔP_v	— pressure drop in vapor
ΔP_{AD}	— pressure drop in adiabatic flow
p	— perimeter of liquid layer
Q	— heat rate
Q_{max}	— maximum heat rate
s	— thickness of liquid layer
T	— temperature
T_s	— saturation temperature
$V_{\ell y}$	— velocity of liquid at y

V_ℓ — flow-averaged velocity of liquid
V_v — flow-averaged velocity of vapor
w — mass flow rate
y — linear dimension away from wall or mass flow rate vapor fraction
α — $A_s/A_{\ell w}$
θ — angle at pipe center intercepted by segment formed by liquid layer in pipe
ϕ — void fraction
ρ_ℓ — density liquid
ρ_v — density vapor

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